tech engineering news

april 1953

Tight reins in the stratosphere

FOR YEARS the performance of bombers and fighter planes at high altitudes has been seriously handicapped by "mushy" controls due to slackness in the cables.

That's because, when flying in the earth's upper atmosphere where it's sometimes as cold as minus 70°F., the aluminum airframe contracts much more than the carbon steel control cables. To take up the slack, all sorts of compensating devices were utilized. They were expensive. Were costly to maintain. They added cumbersome weight. Created potential lags in control response.

Now this problem has been solved. By the logical step of basically improving the control cable itself . . . by developing a steel cable that would contract and expand at practically the same rate as the plane's aluminum frame. It took fifteen years to do it but it was worth the time and cost. We called this improved cable, HYCO-SPAN*.

HYCO-SPAN Aircraft Cable, with a coefficient of expansion 50% higher than high carbon steel, and 33% higher than stainless steel, comes *closest* of any steel cable to matching the expansion and contraction of 24 ST aluminum alloy air frames.

Even without temperature compensating devices, HYCO-SPAN provides positive, responsive control that won't loosen or tighten up, that will remain free of lag and mushiness, and that prevents the development of plane flutter—no matter what the altitude, no matter how big the plane or at what speed the plane is flying.

In addition, HYCO-SPAN Cable, being non-magnetic, has no effect on sensitive airborne electronic equipment. Having the corrosion resistance of stainless steel, HYCO-SPAN stands up well in service in any climate. Its low coefficient of friction permits lower tension loads and improves stability.

HYCO-SPAN Cable is another example of the many interesting products developed and produced by United States Steel. If you're interested in becoming a part of a progressive organization after graduation, why not look into the opportunities with United States Steel? For more details, ask your placement director or write for the informative booklet, "Paths of Opportunity." United States Steel Corporation, Room 2810-S, 525 William Penn Place, Pittsburgh 30, Pa.

**Short for "high coefficient of expansion."*

USS

3-696

UNITED STATES STEEL

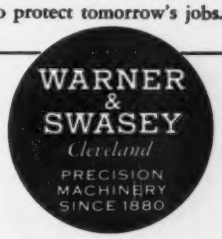
"True-or-False" Quiz on Business

Question	What Most People Believe	The Fact
How big are corporations' profits?	25% (or 25¢ out of each $1 of sales).	7%. In most years actually *less* than 7 cents of each sales dollar.
Who gets the largest share of the income of corporations?	Most people say the owners do.	Actually the workers—they get 86%.
Does war increase corporation profits?	Many people think so.	The facts are—NO. Compared to a good peace year, corporation profits on the sales dollar went down from 6.4¢ to 4.3¢ in the last war.
Do machines put men out of work?	Most people say yes.	NO. In the automobile industry, for example, one man and a machine do the former work of 5 men, yet 20 times as many men are employed. Machines well used reduce costs and prices which broadens markets and so provides more jobs.
Do top executives make too much?	Too many workers think, "If their salaries were divided among workers, our wages could be much higher."	If *all* the salaries of the three top men in the country's biggest company were divided among that company's workers, it would take each worker in that company about three weeks to buy one pack of cigarettes with his increase.
Should taxes on corporations be increased?	"Yes," say many. "Soak the rich."	Truth is that high taxes already take so much money which should be spent in keeping machines modern, that 43% of America's machines are too old to protect tomorrow's jobs.

So much falsehood has been spread about business by communists that workers in their own interest should promote the truth. The best interest of workers, business and all the people is the same.

* * *

Warner & Swasey is a group of men who work hard, respect each other, and enjoy the satisfaction of group accomplishment. If that sort of life appeals to you, write Charles Ufford for employment opportunities here.



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There's no easy way to create a new aircraft engine. *Better designs* for the famous Wasp engines come only after long research — an endless quest for perfection.

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If you would like to work for the company with a future — in an industry with an unlimited future — set your sights on Pratt & Whitney Aircraft.

MORE AIRCRAFT ENGINES BEAR THIS EMBLEM THAN ANY OTHER.

Pratt & Whitney Aircraft's Multi-million dollar Willgoos Laboratory

Pratt & Whitney Aircraft
DIVISION OF UNITED AIRCRAFT CORPORATION
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A MESSAGE TO COLLEGE ENGINEERING STUDENTS

from A. C. Monteith, Vice President in Charge of Engineering and Research, Westinghouse Electric Corporation

There's room to grow at Westinghouse

It's natural that you sometimes wonder about the "elbow room" in the field of engineering. Even though the past half century has witnessed great technological developments, they are only a prelude to the things to come. We have barely scratched the surface in the fields of engineering development and research. And that, most certainly for you, should mean there *is* room to grow.

But first you must find the right starting point—a company which will give you the opportunity you want in your career. Westinghouse offers you this kind of opportunity, for it is a growing company in a dynamic field. Energy is our business. Here at Westinghouse, well planned orientation and training, continued education, position rotation, and management development are all offered to provide you a favorable climate in which to grow.

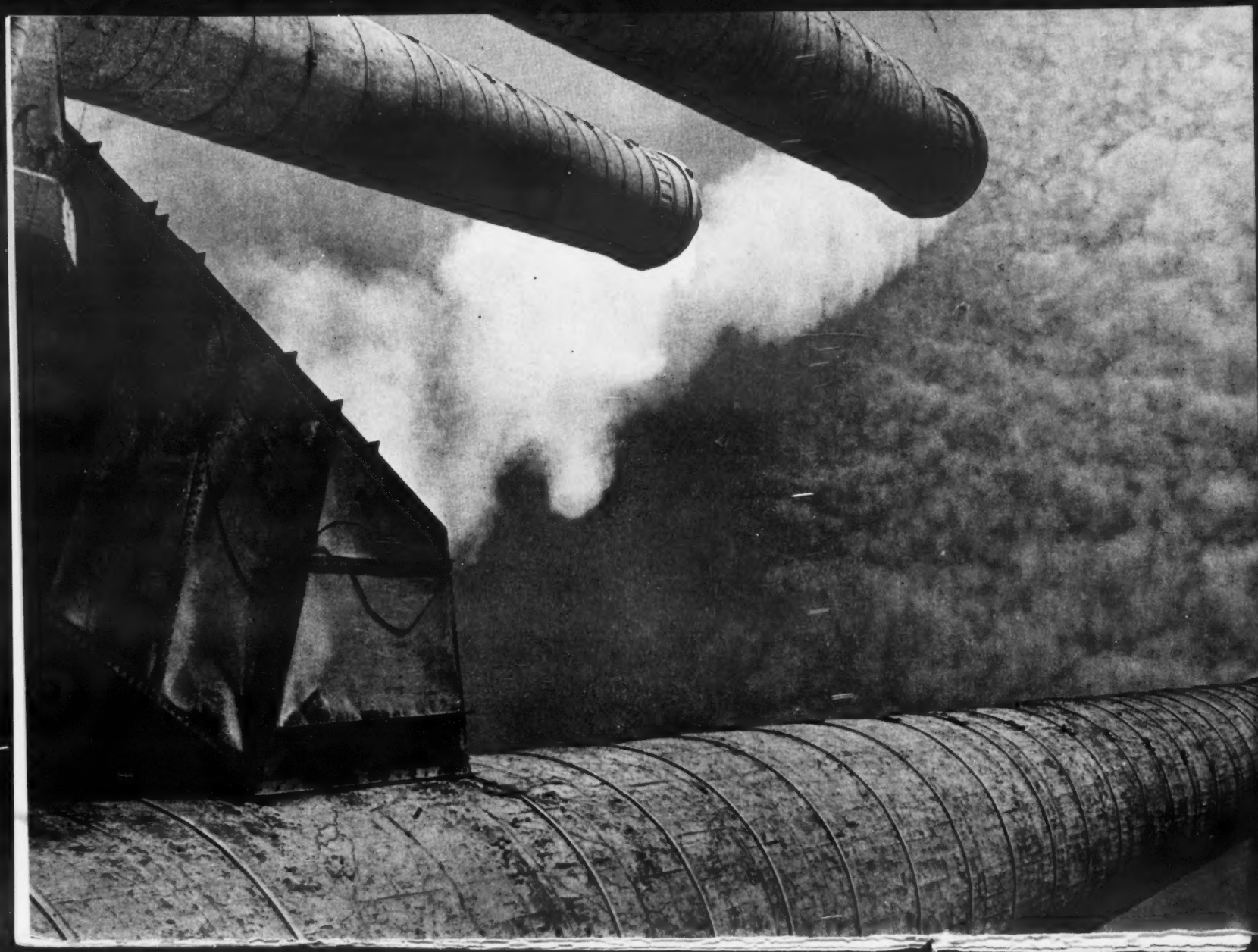
To those who are prepared and willing—whether inclined toward research, engineering, manufacturing or sales—opportunities with Westinghouse are limitless.

G-10252

YOU CAN BE SURE...IF IT'S Westinghouse

For information on career opportunities at Westinghouse, consult Placement Officer of your University, or, send for our 34-page book, *Finding Your Place in Industry.*

Write:
Mr. R. E. Davis
District Educational Co-ordinator
Westinghouse Electric Corporation
10 High Street
Boston 10, Massachusetts



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FRONTISPIECE

Artillery

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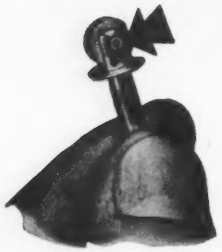
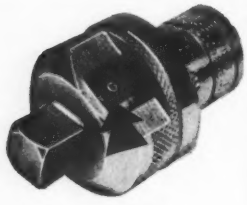
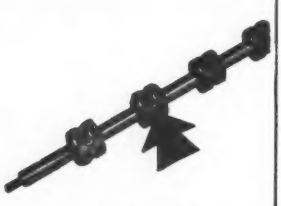


Replacing a rivet

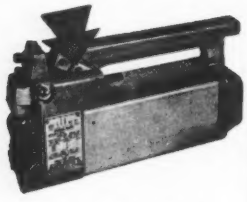
. . . a hinge pin



. . . a stop pin

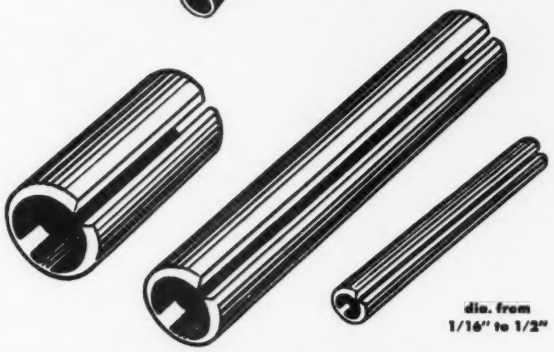


. . . a set screw



. . . a bolt and nut

ROLLPIN



dia. from 1/16" to 1/2"

. . . a modern fastener that saves time and money on thousands of applications

Rollpin is a hollow, split, cylindrically formed pin with chamfered ends. It is simply driven into holes drilled to normal production tolerances. Because Rollpin is slightly larger than standard sized holes, it compresses as inserted. It is self-locking—and vibration-proof—because of the constant pressure it exerts against hole walls. Its shear strength exceeds that of a cold rolled pin of the same diameter. Rollpin is readily removed with a drift or pin punch—and can be reused.

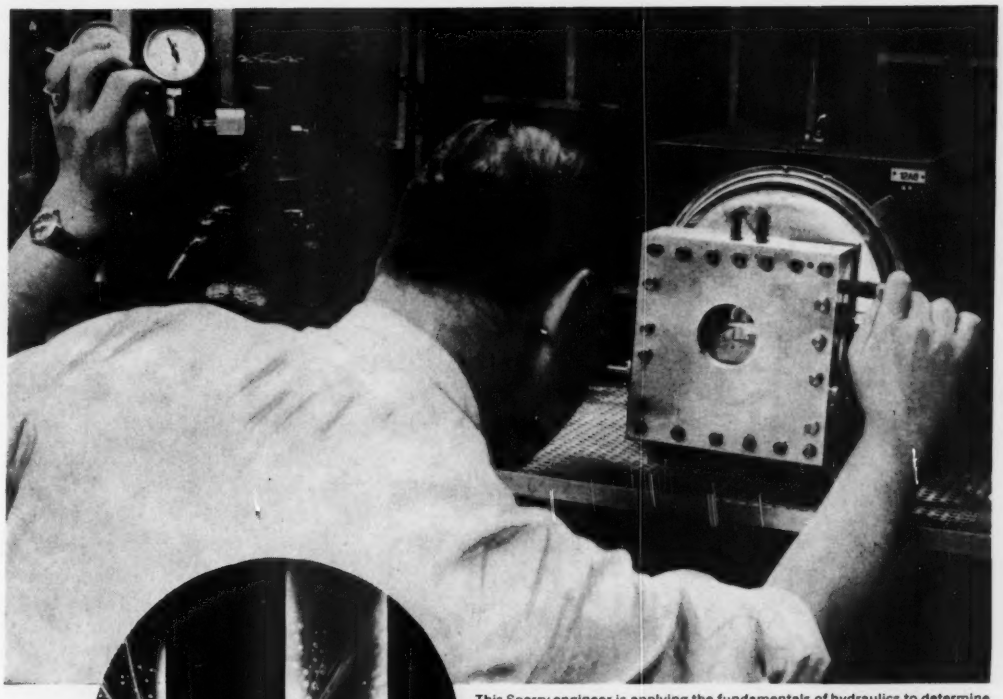
Because of its versatility—and the production economies it makes possible—Rollpin is finding wide usage in almost every phase of manufacturing activity. Write for design information on the Rollpin. It will enable you to cut costs for many applications where use of rivets, set screws, dowels, and straight, serrated or cotter type pins create installation or performance problems.

ELASTIC STOP NUT CORPORATION OF AMERICA

2330 Vauxhall Road, Union, New Jersey

Elastic Stop Nuts with the famous red collar are another ESNA product

ESNA



This Sperry engineer is applying the fundamentals of hydraulics to determine oil flow characteristics at high pressure. Here he introduces nitrogen to the hydraulic fluid in a complex valve to make flow patterns visible for study.

There's Job Diversity at Sperry

FOR THE GRADUATE ENGINEER!

Right now there are openings for...

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- Electrical engineers
- Electronic engineers
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In each field you work with leaders on interesting projects vital to the nation's well-being—long-range projects with a future – projects that call for originality and fresh thinking.

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You'll be proud to say you're a Sperry Engineer. Because, as a member of the engineering staff, you'll share in a forty-year reputation for leadership. Today Sperry is the acknowledged leader in the field of automatic controls for navigation. From Sperry's work in gyroscopics and electronics have come the Gyropilot* flight controller, Zero Reader* flight director, Microline* test equipment, radar, servomechanisms, computing mechanisms, and communications equipment.

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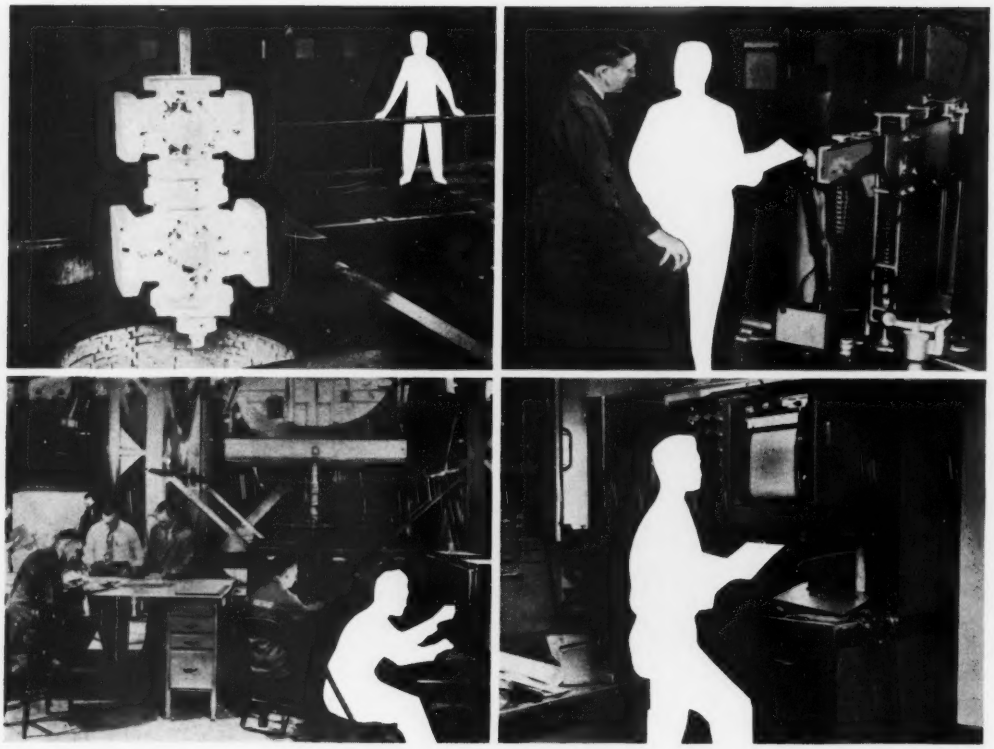

Engineers:

THERE'S A YOU MISSING IN INSTRUMENTATION

If you're still undecided . . . aren't sure which engineering career you'd like . . . still wish you could apply your ability to *more* than just one area of science and industry . . . the expanding instrument and controls field may offer just the career you've been looking for.

Vital to modern technological progress, the instrument field cuts laterally across every segment of industry and research. Here at Leeds & Northrup, for example, we help meet the instrumentation needs of steel mills, auto and aircraft plants, refineries, power generating and distribution stations, atomic energy plants, chemical and pharmaceutical companies. And these are but a few of our more important market areas.

It's this challenge and variety . . . the feeling of playing an important, creative part in many enterprises . . . that makes working for L&N so interesting to engineers.

Our team includes engineers in the field, in product and application work, in research, manufacturing, inspection and other activities.

Why not investigate the *YOU* in instrumentation? Talk over the openings which now exist in our organization with our nearest District Office Manager. Or, if your prefer, write our Personnel Manager, 4915 Stenton Ave., Phila. 44, Pa.

LEEDS [LN] **NORTHRUP**
instruments — *automatic controls • furnaces*

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Detroit 35 Hartford 7 Los Angeles 22 New York 17 Philadelphia 30
Houston 5 Pittsburgh 12 San Francisco 3 Seattle 1 St. Louis 8 Tulsa 3

There's great new opportunity for Engineers in Honeywell's growing Aeronautical Division

The delicately balanced glass of water below clings to its perch, despite the plane's sharp banking turn.

That's because a Honeywell electronic autopilot is in command . . . the human pilot nowhere near the controls.

So precisely are the control surfaces coordinated, that all displacing forces are instantly equalized.

There simply can't be any skidding or side-slipping to upset the glass.

This is typical of aircraft performance made possible by controls produced in Minneapolis by Honeywell's expanding Aeronautical Division.

Besides autopilots, Honeywell's list of current aero products includes electronic fuel measurement systems, dozens of different kinds of gyros, actuators and many other controls.

Today, with aircraft and rockets flying even higher and faster, demands for new controls are being met in the new Honeywell aero plant pictured at left. In developing these new controls, the men in our expanding engineering and research sections often must work in the realm of pure science.

There's real opportunity for engineers at Honeywell—for this is the age of Automatic Control. And Honeywell has been the *leader* in controls for more than 60 years!

The world lives better—works better—with Honeywell Controls

MINNEAPOLIS **Honeywell**

First in Controls

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Gentlemen: Please send me your booklet, "Emphasis on Research" which tells more about engineering opportunities at Honeywell.

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briefing the news

Ceramic aircraft brake . . .

Aircraft brake lining, using one of man's oldest materials, fired clay, to withstand the enormous heat generated in braking heavy, high-speed jets and transports, is now in production.

The new lining, a ceramic-based compound including other highly heat-stable elements, was developed after years of research in the problem of devising a friction surface able to survive aircraft landing impacts which heat brakes to as high as 1,800 degrees in three seconds. Increases in brake energy ratings on the order of fifty per cent and service life approximately five times as great as with the best conventional linings are made possible by the new development.

Typical of modern jet-plane braking requirements is the need for a design to stop 17 tons of plane in 20 seconds from a ground speed of 135 miles an hour. The new lining was developed to control such momentum within wheel and brake size limitations which applied to World War II aircraft weighing seven tons and landing at ninety miles an hour. Now available for commercial aircraft, the new development will meet airline needs for brakes working at extremely high temperatures where long service life is demanded.

Revolutionary anti-tank shell . . .

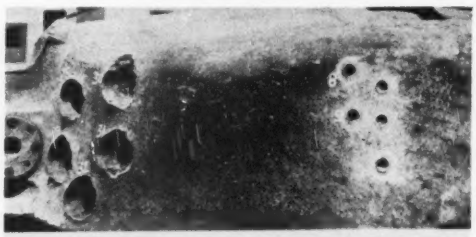
A hitherto classified story of how an urgent "top secret" request from General Eisenhower led to the almost immediate delivery of a revolutionary new anti-tank shell that stopped the German Tiger tanks at St. Lo and is now in use in Korea, has been revealed in Detroit, Michigan. Brigadier General Paul M. Seleen, Commanding General of the Detroit Ordnance District, disclosed the story behind a communique the Ordnance had received in 1944 from the Allied commander which said tersely that on "D plus 30" the Allied spearhead was being seriously slowed by the new Nazi tanks and their incredibly thick and impenetrable armor shielding. The commander pointed out that an anti-tank shell which could penetrate this armor would prevent slowing down or even stopping the Allied invasion.

Army Ordnance had been developing a new shell, but no such shell was ready for use on Friday, July 7, 1944. But that didn't stop Ordnance. They flashed the word to Detroit where much of the development work was being carried out. Here, Ordnance had worked closely with companies turning out tremendous quantities of cutting tools of the hardest metal made by man — tungsten carbide. This comparatively new metal was making it possible to manufacture war materiel in a fraction of the time it would have otherwise required.

The Army was aware of the fact that the companies had provided tungsten carbide for its development work. However, they knew that these initial trials were far from completion. Would it be possible, the Army asked, to get some shell cores made immediately?

They got their answer. Within two days ten cores were ready for test firing at Aberdeen Proving Grounds. In normal times, delivery of ten new shells such as these would have taken months or even years, and these were not "rough" models. The shell cores had to be held to comparatively close tolerances. In general, the finished shell had to be similar to existing 76 mm. rounds if they were to be used in guns then at the front.

At nine o'clock on Monday morning, July 10, the first ten were shipped by a special Army plane to the testing grounds in Maryland. On Thursday, Aberdeen sent the news: "The answer to the German Tiger had been found — firing at even a 20-degree angle, these Carboloy cores would penetrate the thickest armor." Up to this point the pace had been fast — and it was to get even faster. On Thursday evening complete information was gathered on mass producing the core. The Army was told that plant capacity was non-existent; tungsten carbide was already being made at peak production capacity; and equipment to make anti-tank shells was all working overtime elsewhere. In spite of these hurdles, the production effort was started. A grinder was flown in from Connecticut. A steel storing shed at the plant was cleared of more than 20 tons of steel in three days, a job that would normally take weeks, and it was done by hand because



the cranes were working in another area. Two machines destined for the Orient were unloaded from a ship at a San Francisco dock. A Detroit manufacturer built a special sintering furnace in a record 19 hours. Hydrogen had to be brought in for this furnace. It was found in Ohio. This would require special trucks to take it to the plant in Detroit, so the Navy provided them from one of their Texas bases.

In less than two weeks, production was underway on Ike's cores. As fast as the shells were assembled, they were loaded on cargo planes and sped straight to the front; there were no time-consuming "channels" of transportation for these shells. And it wasn't long after they were unloaded from the planes in France that they were being "loaded" again; this time by our anti-tankers who were aiming them at the enemy.

Today, these same type shells are being used on the Korean front by M. I. T. ROTC Ordnance Students.

Opportunity

knocks on many doors at General Motors

HOWEVER lofty your ambition, or specialized your technical training, you'll find opportunity behind a great many doors at General Motors.

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Naturally, this diverse activity calls for a varied array of engineering talents—mechanical, electrical, chemical, metallurgical and industrial. And it calls for all the imagination and ingenuity a young engineer can supply.

Moreover, the environment at General Motors is especially conducive to advancement and success. For all work is decentralized among GM's 33 manufacturing divisions, its 111 plants in 55 towns and cities throughout the country. And although each division operates as an independent unit with its own engineering department, each can draw upon the resources of GM's central research and engineering laboratories.

Thus is combined the friendly, intimate atmosphere of a small organization with the scope, facilities—and opportunities—of a large one.

So a young engineer, who has what it takes, can take what General Motors has—and fashion a noteworthy career for himself in his chosen field. Many engineering graduates now in top jobs at GM can vouch for that.

Why not check with your College Placement Office and arrange for an interview with our GM College Representative the next time he visits your campus? Or if you prefer, write direct to us.

GM positions now available in these fields:

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METALLURGICAL ENGINEERING	INDUSTRIAL ENGINEERING
CHEMICAL ENGINEERING	BUSINESS ADMINISTRATION

GENERAL MOTORS CORPORATION

Personnel Staff, Detroit 2, Michigan

How to keep from blowing your stack . . .

Lightning reacts to a towering industrial smokestack much like a bull to a red flag. Because these stacks are usually the highest structure around, lightning charges full steam at them. If the stacks are well protected, all is well; if not — you literally pick up the pieces.

Recently an industrial firm wanted to try a new system of protection, but first they naturally wanted to know if the idea was sound. The problem of protection has a standard solution, two external down conductors on opposite sides of the stack, connected between air terminals at the top of the stack and ground. Supplementing this in reinforced concrete stacks, the reinforcing metal is electrically interconnected, and joined to the down rods at the top and bottom.

The question was — could the external conductors be eliminated and depend solely on embedded conductors (either the reinforcing steel or a separate conductor) electrically connected to the air terminals at the top of the stack and grounded at the base? Would the high currents of the lightning bolt blow the stack apart? Results show that they will not — if the internal electrical connections are solid.

To demonstrate this, engineers constructed a concrete cylinder, in which small conductors were embedded. Conductors were two types, bare and cotton braided. The latter was used so that it might be saturated with water to simulate the condition where the down conductor and the concrete did not make a close bond, and the rain seeped down between wire and concrete. Under such conditions it was conceivable that the heat of the wire would turn the water to steam and damage the stack by pressure.

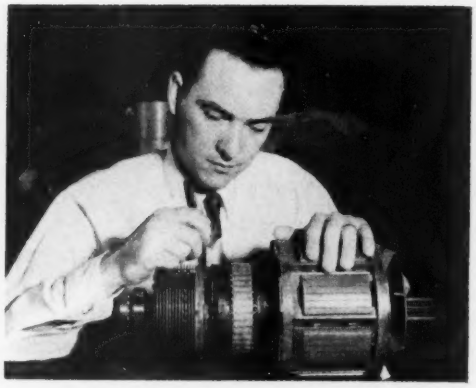
The "stack" represented by the concrete cylinder was then tested under a variety of conditions with the result of no damage.

To simulate cracks in the concrete a special cylinder was made with a number of fine radial holes from the conductor out to the surface of the concrete cylinder. Several grounded copper bands were wrapped directly over the holes. A surge current ruptured the cylinder at the location of the bands, due to the destructive effect of the current jumping from conductor to band. This illustrates the case where external down leads are used jointly with internal reinforcing metal, where the two are not joined electrically at the top, but only at the bottom. The tests show that, if external down leads and reinforcing metal are used in conjunction, they must be joined top and bottom. They also show the destructive effect of lightning currents at joints of embedded conductors that are not electrically connected.

The lesson learned: as long as embedded conductors are solidly connected, the scheme is sound; an open or poorly conducting joint would be catastrophic. In short, the scheme of using only embedded conductors (either the reinforcing metal or separate conductors) is successful as long as electrical connections are solid. The usual aerial terminals and a solid ground at the base of the stack are, of course, requisite.

An alternator without brushes . . .

When an aircraft-power-supply engineer indulges in pleasant daydreaming he contemplates the banishment of brushes. In aircraft service, particularly, brushes are troublesome.



Designers of aircraft alternators have produced one solution to the problem of brushless alternators that is commanding respect. The alternator itself is essentially standard. The trick is in the excitation supply. On the shaft with the alternator is a rotating armature a-c exciter, the output of which is fed to a bank of selenium rectifiers rotating with it (see photograph). The rectifiers deliver direct current to the alternator field.

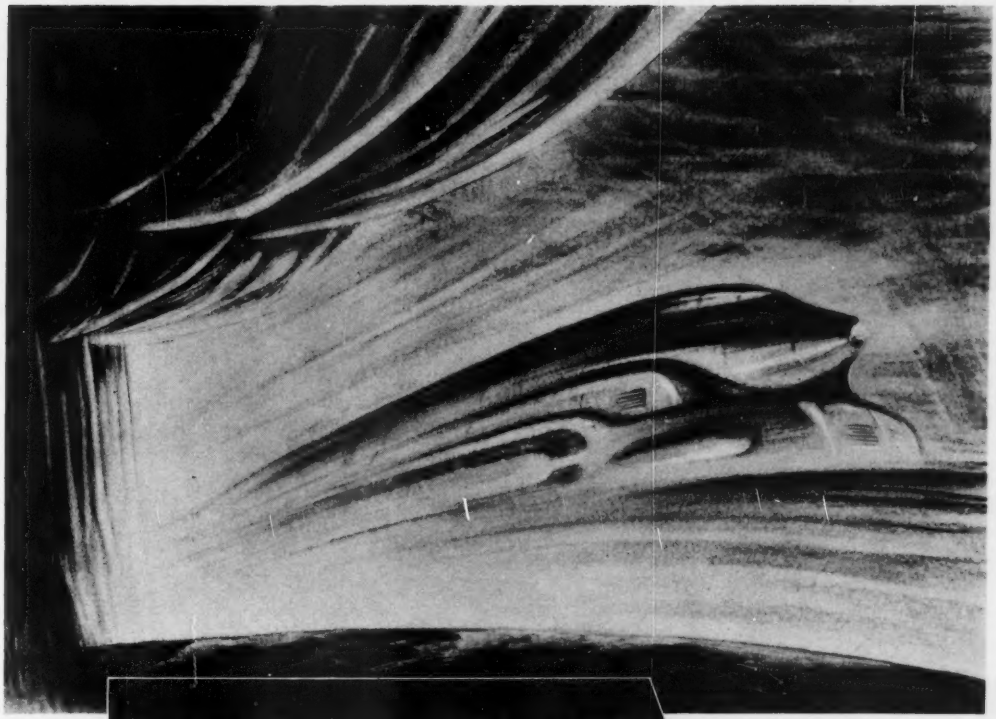
Preliminary tests are gratifying. The alternator, which normally would run at 4000 to 8000 rpm, has operated on an overspeed of 11,000 rpm with no apparent damage to the rectifiers or other elements. An experimental 60-kva machine was built into the frame of a standard 60-kva alternator with space to spare. It has carried 150 per cent load for five minutes and has survived short circuits of 200 per cent for five seconds, and 300 per cent for three seconds. The overall efficiency is slightly better than a standard slip-ring machine, exceeding 90 per cent from half load upward. The weight of production models will probably be no more, and possibly less, than for conventional machines.

The usual rate-of-change signal from the excitation circuit used to stabilize the voltage regulator is no longer accessible. An extra coil on the exciter field supplies this anticipating signal very nicely, however. The output of the coil is fed to a regulator coil and gives an anti-hunt signal in just the right phase with respect to the alternator field to damp out the tendency to overshoot and oscillate. Perhaps the alternator designer will make his own favorite dream come true.

Simplified diesel load regulator . . .

Evolution in railroad diesel load regulators will soon take all of the skill out of dining-car coffee drinking. The smooth starts and stops are getting smoother as a result of continual improvements in the "workings" of the regulator system.

Speed control of the diesel locomotive is accomplished by regulation of the diesel-engine power and the exciter-field voltage. Two years ago, a carbon pile was used in the load regulator to adjust the exciter-field voltage. The principal drawback to this regulator was the lack of definite steps of resistance, or definite maximum and minimum values. A rheostat, made up of tapped resistors connected to a commutator, and jointly controlled by the throttle and the improved load control, now eliminates this disadvantage. When a locomotive unit now works with others, all share the work evenly, both in starting and in dynamic braking.



BEYOND THE HORIZON....

Designers are seeking new alloys from the metallurgist in order to develop higher speed transportation.

Higher speed calls for materials having greater strength in lighter sections, often with little or no sacrifice in toughness. Molybdenum contributes vital properties to better alloys which will certainly be developed for the future.

Climax furnishes authoritative engineering data on Molybdenum applications.

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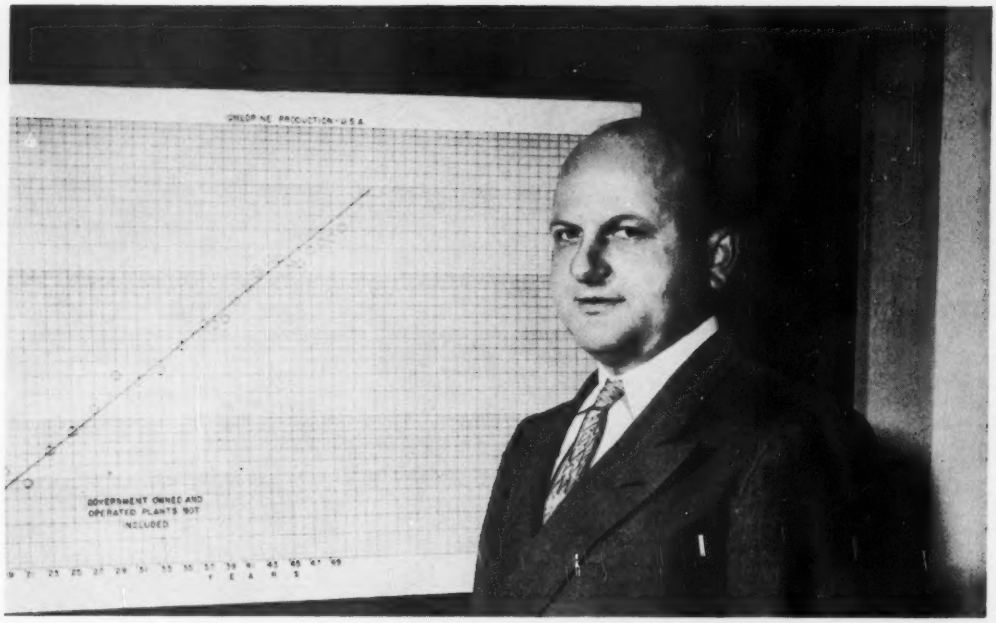

"...Give him the opportunity to grow"

This is Joseph A. Neubauer. He is an important member in the Columbia-Southern organization.

Right now, Mr. Neubauer is Technical Director of the Corporation. He has been on the move, upward, ever since he joined Columbia-Southern after graduation from college.

His progress is worth emulation. But initiative alone is not always the answer to a man's career. You can't launch an ocean liner in a mountain stream. Neither can a man travel far in an unprogressive, stagnant organization. A man needs freedom to put his ideas into action; he needs to move ahead without waiting for vacancies to occur from death or retirement. We believe Joe Neubauer's story will interest you and give you something to think about.

He graduated with a Bachelor of Science degree in Chemical Engineering from Case Institute of Technology in 1932. In 1933, a depression year, he joined Columbia-Southern as a production operator. Within a year, he was named shift foreman.

Shortly afterward, Joe was assigned to the Development Department to work out some problems involving the Soda Ash process. Following this he supervised the engineering and construction of Columbia-Southern's first chlorine unit at the Barberton, Ohio plant. He became assistant production manager at Barberton and, in 1942, was assigned to engineering and construction of the plant at Natrium, West Virginia.

He was elevated to superintendent of operations at Natrium and in 1946 moved to Pittsburgh as technical assistant to the Vice President. In 1949 he was named Technical Director of the Corporation.

Just this past year he was sent by Columbia-Southern to take the Advanced Management Program at Harvard University.

Joe Neubauer has some good advice to pass on to the 1953 graduate. "The main thing for a graduate is to select a company which will give him the opportunity to grow. In the Columbia-Southern organization, the road to top positions is open from many fields . . . whether it be sales, chemical engineering, electrical engineering or various other backgrounds. I would strongly advise any graduate who has an interest in the future to look into the opportunities at Columbia-Southern."

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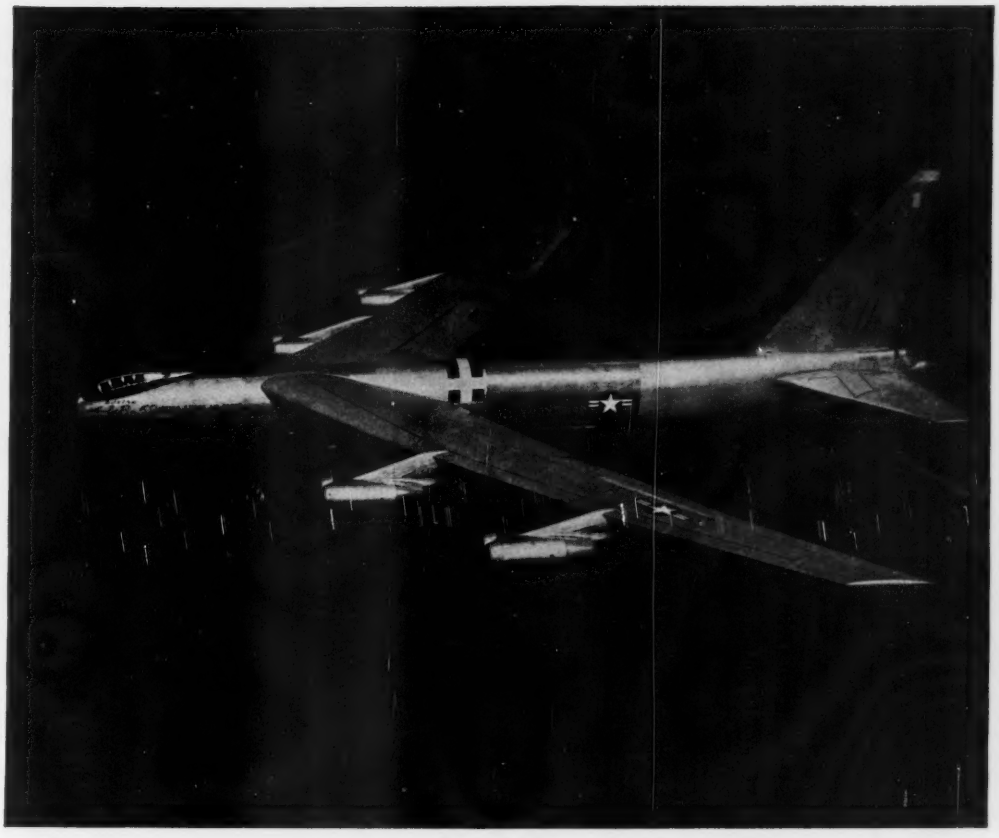

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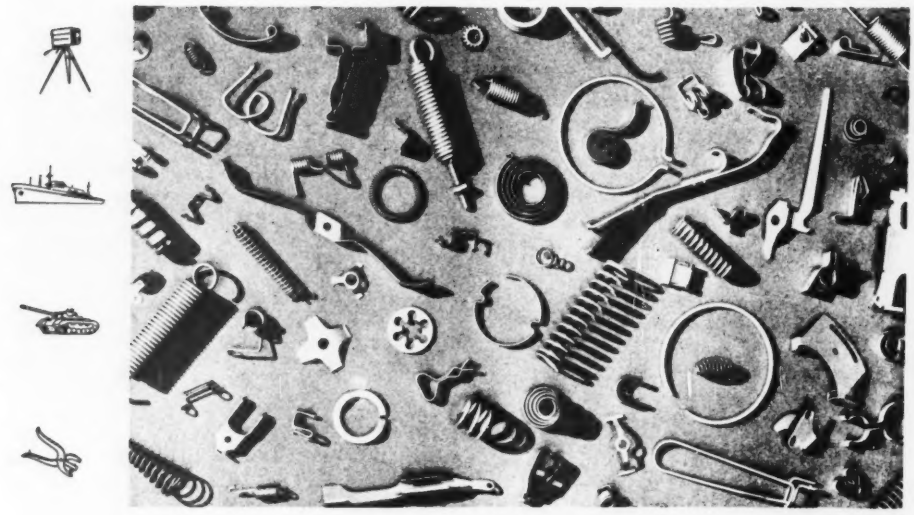

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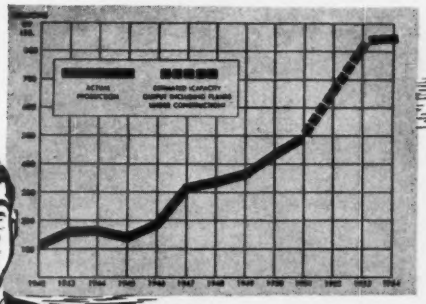

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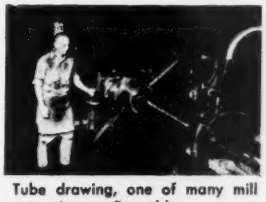

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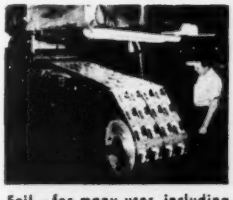

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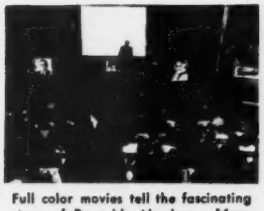

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pharaoh's engineers

By Garry L. Quinn '56

The engineer is prone to regard himself as a member of one of the most "modern" professions. It is true that engineering did not begin to take its present form until after the Dark Ages. It cannot be forgotten, however, that many of the most momentous achievements of the engineer's art date from hundreds or thousands of years before Christ.

On the other hand, some people look upon the ancient counterpart of the engineer as a mystic or perhaps a magician. At least it is thought by many that the ancients possessed technical knowledge beyond anything known today. The most likely reason for this idea is that we have no contemporary accounts of early works of engineering, some of which occurred before the very dawn of history. There are no photo albums of the construction of the pyramids. The only records lie in the works themselves. Fortunately many of these works have endured. For example, some Roman roads constructed in the time of the Caesars are in daily use today. How favorably they compare with our own highways, many of which are unserviceable after only a few months!

The penchant of ancient monarchs for erecting enormous monolithic monuments is well known. In their monuments and public buildings monstrous blocks of stone were often used. Two statues of Amenhotep III in the great plain of Thebes, each made of one block, weigh eight hundred to a thousand tons apiece. It is natural that we ask how the men of the past, lacking our great machines, were able to transport these rocks and put them into place.

Work (as the freshman knows by now) is the product of power by time. In the airplane-less, auto-less civilization of a thousand years ago, time meant little. It was, therefore, left for the engineer to find a convenient source of power. In overpopulated Egypt and in the slave-based economies of Greece and Rome, the cheapest source of power was man. Little was known of the power of steam, and nothing at all of gasoline. The food necessary for one ox would feed four men, and the men could be much better regimented.

Still, the misconception holds that the ancients had miraculous devices with which to direct their human power to best advantage. Actually they possessed only what we now know as the simple machines: namely, the lever, the wheel and axle, the pulley, the inclined plane, the wedge, and the screw. In addition, the Romans were acquainted with some of the effects of torsion, shrinkage from wetting, and the elasticity of a spring. The Romans and possibly the Egyptians knew the advantages of the compound pulley. By the application of these simple mechanical powers, the ancients accomplished some of history's greatest engineering feats.

In "Mechanical Problems," a work commonly attributed to Aristotle, the author enumerates the machines in use at his time. The list includes the lever, balance, steelyard, tongs, wedge, axe, winch, roller,

The Pyramids at Gizeh, showing height of plateau.

wheel, pulley, compound pulley, potter's lathe, sling, and oar. The lever was undoubtedly the first machine to come into use. Our arm acts as one kind of lever whenever we pick something up. The cave man must have used a stick as an extension of his arm, and soon discovered that he could lift a greater load if a rock was placed under the stick between him and the object to be lifted. One of the earliest applications of the lever, and one still in use in Egypt, is a water-lifting device called the shadoof. The shadoof consists of a lever with two arms of unequal length. To the shorter, rear arm is attached a weight, and to the longer arm a scooping vessel. By applying force to the long arm, a workman can easily raise or lower the vessel. Another application of the lever which filled a need in the economic life of Egypt is the equal-arm balance.

The inclined plane was early recognized as a convenient means of lifting great weights. As we shall see, the inclined plane played a major role in the building of the pyramids. It acquired particular importance by being used in the form of the screw, which is supposed to have been invented by Archimedes. Inasmuch as Archimedes spent much time in Egypt studying the technology of that early civilization, we may suppose that the screw and other devices attributed to him had been known in some form in Egypt. The pulley, although known early, was used for a long time merely to change the direction of a force. It is not known when it was first discovered that a movable pulley attached to the object or a system of pulleys will increase mechanical advantage. We know that the Romans and the Assyrians used the complex pulley, and it is frequently conjectured that the Egyptians used similar devices. The windlass is a special variety of pulley which is set into motion by lever action. It was much used in Roman times.

Claudia and Anio Novus near Porta Furba. Repairs in brickwork and in a composite of concrete and brickwork.

The Egyptians were used to transporting huge masses on a kind of sledge-runner. Many ancient carvings show such sledges sliding on logs. It is natural to assume that these logs were, at least some of the time, round. Round logs gave rise to that most useful invention, the wheel. Various ancient civilizations, including those of Assyria and Egypt, possessed wheeled vehicles. Out of the wheel, in turn, developed the toothed wheel, the basis of most modern machinery. In the mills, the wheel found its chief application. The water-wheel was known in antiquity only in the undershot form.

The force of elasticity was exploited by the ancients particularly in devices of war. The simple bow is the oldest of all weapons for projecting missiles. Homer often mentions the bow, but he indicates that it did not play an important part in the battle for Troy. A natural development of the bow was the arbalest or crossbow. Far surpassing the bow were the Romans' ballistic machines, in which tension was generally brought about by twisting a cable composed of several strands. Some of these machines could produce pressures up to fourteen tons.

The history of engineering closely parallels the history of civilization. Indeed, civilization could not have arisen if the elements of engineering had not been known. Without means of water supply and of fortification, for example, the first towns could not have existed.

The world's first major civilization arose in Babylonia or Mesopotamia, the "land between the rivers" Tigris and Euphrates. This land was singularly deficient in metal and stone. Although marble, limestone, copper, lead, and iron could be obtained from neighboring countries, the cost of transportation was so high that Babylonians relied mainly on bricks of sun-baked clay for construction material. These bricks, bound with mortar made from bitumen or asphalt, were fairly durable in the dry climate of Mesopotamia.

The chief city of Babylon, according to the Greek historian Herodotus, was designed as a square fourteen miles on a side, split in two by the Euphrates. All four sides of the city and both banks of the river were protected by a wall said to be three hundred feet high and seventy-five feet wide at the top. The core of the wall was of sun-dried brick in a bitumen base, and the facing of a harder and more durable kiln-dried brick. Outside the wall was a moat filled from the Euphrates. Each side was pierced by twenty-five gates. From each gate a straight road ran to the corresponding gate in the opposite wall.

The most famous feature of ancient Babylon is the "Hanging Gardens," which did not hang at all, but simply were raised high above the level of the surrounding plain. The structure was four hundred feet on a side and seventy-five feet high, rising on superposed tiers of arches. The platform on top was covered with a great mass of earth in which grew flowers, shrubs, and even trees. Water from the Euphrates was supplied by a device similar to Archimedes' screw. Great care was taken to prevent damage to the masonry by moisture. Between the earth and the brickwork was a layer of reeds mixed with bitumen, a double layer of burned bricks cemented with gypsum, and finally a coating of sheet lead over the masonry itself. Surpassing the hanging gardens as a miracle of architecture was the Temple of Bel, a mass of brickwork towering as high as a modern fourteen-story building. Of the structure's eight stories, the top one was a spacious temple. As each level was a different color, the temple must have been a spectacular sight in the gleaming Babylonian sun.

The world's greatest and oldest monuments are the pyramids of Egypt. In all, there are sixty or seventy pyramids. The three most notable stand on a plateau one hundred feet above the desert at Gizeh, on the Nile near the ancient capital of Memphis and the present capital of Cairo. The largest and best known is the Great Pyramid of King Cheops or Khufu, who ruled about 2900 B.C. Before his time only one or two smaller, terraced, pyramid-like structures had been built. The Pyramid of Cheops is 756 feet square and 493 feet high. Into its construction went 2,300,000 blocks of stone weighing two to sixty tons each. It covers thirteen and a half acres and has a volume of eighty-nine million cubic feet — two and a half times that of the Empire State Building. The bulk of the pyramid is limestone from the quarries of Masara and Tura on the other side of the Nile. The structure was covered with a casing of polished granite quarried at Assuan, several hundred miles up the Nile. The second pyramid, built by Cheops' successor Cephren, is somewhat smaller than the first, being 707 feet square and 454 feet high. The third pyramid of Gizeh, that of Menkure, is considerably smaller than the other two but the finest in workmanship.

A person regarding the pyramids for the first — or for that matter, for the twentieth time — wonders what force brought together the millions of tons of stone comprising them. As we have already indicated, the force was that of human beings. Herodotus reports that one hundred thousand men labored for twenty years to build the pyramid of Cheops. It is likely that that number of men worked on the pyramid not continuously, but during the three months or so of each year when the plain around Gizeh was covered with the waters of the Nile, and no agricultural activity was possible. Teams of hundreds of men drew huge blocks of stone from the quarries down an inclined plane to the Nile, where they were drawn onto a ferry in the form of a raft or lighter. On the other side of the river was another inclined plane leading to the edge of the plateau. A separate causeway was built for each pyramid. That for the pyramid of Cheops was three thousand feet long and 120 feet high — a grade of one part in twenty-five. Herodotus calls it "a work not much inferior in my judgment to the pyramid itself."

Once the rocks were at the pyramid site, they were cut to shape. The longest slab in the bottom course is but a fraction of an inch longer than the shortest. The facing blocks, which have long since been removed to build half of Cairo, fitted so closely that a pin could not be inserted between any two. For cutting tools, the builders used straight saws, circular saws, and tubular drills with jeweled cutting points. Green stains on some of the blocks show that the saws were made of bronze.

The question most often asked about the pyramids is how the massive blocks, once at the site, were lifted to their places in the upper courses. Several workable explanations have been offered, but none is generally accepted. Herodotus describes the building operation as follows: "This pyramid was built in the form of steps which some call *crossae*, others *bomides*. When they had first built it in this manner, they raised the remaining stones by means of machines made of short pieces of wood: having lifted them from the ground to the first range of steps, when the stone arrived there, it was put on another machine that stood ready on the first range: and from this it was drawn to the second range on another machine." Unfortunately no one has yet offered a satisfactory explanation of what a machine made of short pieces of wood looks like. Some authorities think that it was a compound pulley supported by two-legged sheers. Another conjecture is that it was an "A" frame with its feet fastened to the stone platform and its frame at a forty-five degree angle with the vertical, so that a horizontal pull on a rope attached to the top would impart a vertical movement to a block suspended from the top by another rope.

In any event, Herodotus is questioned by another ancient historian, Diodorus. Diodorus claims that the pyramid was built with the aid of inclined planes. It is reasonable to assume that the causeway from the Nile to the plateau top was extended to the pyramid. A simple extension would make it forty feet above the plateau at the pyramid. We may conjecture that the plane was raised to at least the two hundred foot level, for the heaviest slabs are found at that height. The grade of such a ramp would be one in seven, which is not impossibly steep. To those who point out that the causeway would require four times as much work as the pyramid itself, we repeat that human labor was the cheapest commodity in ancient Egypt.

Inside the pyramid of Cheops is an elaborate system of corridors and chambers. The entrance is located in the north wall at the nineteenth course of stone. The two main rooms are approximately on the vertical axis of the pyramid, one below ground and the other just halfway from the base to the apex. In the upper room, known as the King's chamber, is a simple, flat-sided coffin cut from a single block of red granite. It is generally believed that the pyramid was meant as a tomb for its builder as well as a monument to him. Forming the roof of the King's Chamber are nine great blocks, laid side by side so as to form a ceiling. Above the ceiling is a unique structure of five open spaces alternating with blocks of granite. Above the highest open space are granite slabs leaning against one another in an

Claudia, of dimension stone, and Anio Novus, of brick and concrete, on top of it.

inverted "V" such that all stress is relieved from the chamber below.

Leading from the King's Chamber to the faces of the pyramid are two small ventilating shafts. It has been pointed out that when the pyramid was built, the rays of the star Sirius — sacred to the Egyptians — when at culmination passed through the ventilating shafts and fell upon the coffin of the king. Many other mathematical and astronomical oddities have been discovered in the pyramid. The faces point exactly to the points of the compass. The ratio of the height of the pyramid to the perimeter of the base is equal to the ratio of the radius of a circle to its circumference. Other natural units of the pyramid express the distance of the earth from the sun, the nature of the earth's orbit, and so forth. All the unique properties of the pyramid of Cheops cannot be accidental.

After having dwelt at length on the technical achievements of the world's earliest civilizations, we are left without space to deal fairly with the works of somewhat later cultures. To attempt a survey of the works of the Greeks and Romans would be folly. We shall therefore spend the remaining paragraphs describing just a few examples of Graeco-Roman engineering.

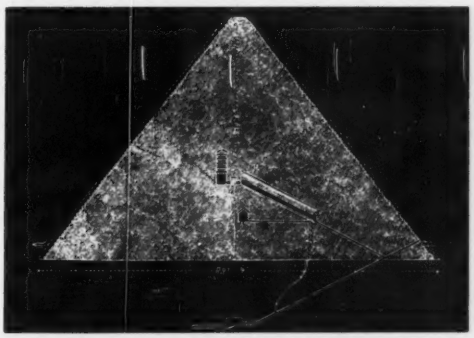
In an ancient civilization, no public building was more popular than the theater. The oldest form of the theater was little more than an enclosed lawn in which performances were given, while the spectators stood around. Later, in order that the action would be easier to follow, a wooden stage was added. The stage was often placed at the foot of a hill, on the slopes of which the spectators stationed themselves. For their comfort, terraces were cut in the hillside to act as seats. A later addition to the theater was a wooden booth from which the actors made their entrances and into which they made their exits. As the theaters accommodated up to twenty thousand people, it was necessary for the actors to wear special masks which strengthened their voices.

The amphitheater was essentially two theaters placed together, or an orchestra entirely surrounded by tiers of seats. The amphitheater was built in the form of an oval as long as possible, to allow freedom of movement. Inasmuch as the stands were supported by pillars and walls, there was room for an extensive system of corridors below it. Cages for wild animals were often fixed under the lower level of seats or in annexes. The lowest circle of seats was generally separated from the arena by a wall. The grand scale of the amphitheaters is well-known. The Coliseum at Rome seats 45,000 to 50,000 people.

One of the great achievements of Roman engineering skill was the Empire's vast and far-flung system of roads. By making all parts of the world readily accessible to the legions, the network of roads radiating from the city of Rome contributed heavily to the permanency of the Empire. Unlike the spontaneously arising trade roads, ancient military roads were laid down with the greatest care and technical skill and were kept in an excellent state of repair. The total length of paved roads in the Roman world was over 47,000 miles. When building a road, the ancient engineer aimed for the shortest route, no matter what obstacles intervened. The road itself was built to last forever.

The most famous of Roman roads, and an excellent example of the Roman road-building technique, is the Via Appia, or Appian Way, which stretches 360 miles from Rome to the ancient town of Brundisium. The first step in the building of the Via Appia was to dig two parallel furrows which were to mark the limits of the roadway and at the same time to act as drainage ducts. The earth between the furrows was removed and replaced by a bedding of sand or mortar. Along the sides ran rows of large curb-stones. The first course above the bedding consisted of large flat stones cemented with lime mortar or clay. Higher layers were made from smaller stones, gravel, sand, or concrete. Finally a paving of polygonal slabs of stone was put in place with greatest care. The finished highway was two and a half to five feet thick and was concave upward so that rainwater would drain away.

Before closing let us shift the scene briefly to Asia. While the empires of Greece and Rome were flourishing along the Mediterranean, an independent culture was evolving in far-away China. In 240 B.C. the Chinese monarch decreed a work designed to protect his people from the warlike Mongols to the north. Soon a great party of men began work on a great wall intended to encircle China from the Pacific to the Indian Ocean. Although it reached only half its planned length, the Great Wall of China stretches overland for 2,550 miles from the Pacific to the mountains of Tibet. Its volume



Vertical section through the Pyramid of Cheops.

of 300,000,000 cubic yards makes even the Pyramid of Cheops seem but a thimbleful of gravel.

A representative segment of the Great Wall is twenty-five feet wide at the base, fifteen at the top, and thirty feet high. Its foundation and lower part is of cut stone blocks joined with great skill. The upper part is faced with three or four layers of large bricks laid in mortar of excellent quality. Earth, gravel, and loose stones form the core of the wall. About every 250 yards a watchtower rises from the wall itself. Each tower is pierced by two openings so that travelers and vehicles using the top of the wall as a thoroughfare may pass through.

It has been said that the Great Wall of China is the only single work of man which would be visible from the moon. Perhaps one day, some engineer, standing on the moon and gazing at the earth rising in the sky, may be reminded of his heritage from the ancients.

*HE ADVISES THE FACULTY

freedom, authority, and self-determination

By Prof. Karl W. Deutsch

Professor of History, M.I.T.

It is for this type of social groups and organizations — organizations intended to endure — that the problem of freedom and authority has been most seriously posed. The various answers to this problem, we may now venture to suggest, may perhaps be worth evaluating, in terms of this overriding aim of enduring growth and self-determination, both for the individuals, for as long as their lives may last, and for their children and their communities and groups, whom they so seriously intend to live longer.

The underlying problem of long range growth becomes visible as soon as we begin to search for the greatest freedom of each individual. Freedom we may well define as a range of choices, and we may hold that a man's freedom is greater if this range is wider, and provided that the choices are significant and real. By real choices are meant choices based on the presence of actual opportunities for action, and not on the mere absence of restraint; furthermore they are opportunities offered to individuals capable of using them and aware of their existence.

We may accept the fact that certain ranges of choices, and thus kinds of freedom, may have to be traded for each other. The wider range of automobile travel, as compared to walking, implies at the same time the narrower range of the automobile's dependence on hard surfaced roads. Similarly, the wider range of choosing among one's employment opportunities under governmental policies of full employment, may well involve a narrower range of certain business or investment transactions left to private individuals. Yet if all men are considered as ends in themselves, or as children of God, and hence as potentially equally valuable, it should be possible to estimate any major overall gain or loss involved in such exchanges of one type of freedom for another.

So far nothing seems to stand in the way of the pursuit of ever broader vistas of individual freedom — except that no man can live long enough to pursue them forever. The search for the greatest possible freedom during one's lifetime comes up short against the inescapable fact of death, and the only answer which we have found thus far has been to extend our "I" beyond ourselves, to identify ourselves with something that is greater than we are and that will live longer.

If death threatens our freedom, we thus regain it by extending our identification into space, and particularly into time. But if we do this, our previous calculations of the greatest freedom within our lifetime can no longer be trusted. We must now take account of future generations, of the unborn who we hope will still come after us. For their sake we must conserve some of the resources and perhaps renounce some of the opportunities for enjoyment and consumption which now seem before us.

On this claim of the long future, Edmund Burke based some of the strongest of his arguments for conservatism and authority. He reinforced this claim by pointing to the uncertainty of human predictions. As the predictions of no single generation can be trusted — for every single generation is but one of "weak and giddy men" — the long future must call on the long past. Authority then seems to be the voice in which this past and this future speak together.

In a context of communications, we may think of *authority* as a property of those messages to whom preferred treatment is given for reasons other than for the sake of their own content. The voice of authority, more shortly put, is that voice which is listened to and whose advice is more or less willingly taken.

Authority, then, means a claim to deference. We defer to authority for various reasons. Authority may reside in a single individual whose messages are arbitrary. Or it may reside in a leader who has become the object upon whom his followers have projected their own hope and expectations until he seems to them endowed with a gift of charismatic leadership. Finally, authority may be diffused among the members of a "veto group," whose messages must be listened to and deferred to, in regard at least to that limited range of topics which is within the effective range of the veto group's power. Or authority may be still more widely diffused among the members of a peer group of one's equals among whom "it does not pay to get out of line."

In all these cases a strategy of deference has been established, in regard to certain classes of messages coming from specified external sources, or perhaps containing specified symbols. However, this strategy of deference may be internalized by at least some of the persons who have come to accept it. Generalized rules concerning which messages to accept, and which ones to reject or repress, have now become part of the personality structure of certain individuals. Authority to them now speaks with an inner voice. It may appear to them as the voice of tradition, or as a code of thought and conduct, or as a spirit of a community or group, which imposes upon them a strategy in the selection of those values and preferences which they may henceforth espouse.

So far as the treatment of messages is concerned, it would seem on this showing that, among the members of a social group or organization, authority is simply an operating preference writ large. It represents a particular aspect of the inevitable necessity of having some channel configuration, some operating preferences, some stable pattern in the distribution of messages and chan-

nels. Without it, it would seem, the communication system of the organization would be flooded by what communications engineers call "noise," and what some political scientists have recently called "anomy." Authority, according to this reasoning, is simply indispensable. The only problem is to make it strong and stable, to give it some small share of consistency, and to anchor it in the slowly learned habits and personality structures of the population. Where this has been accomplished, authority has been made legitimate, and with legitimacy once achieved the system seems to lack little to perfection.

Yet there remains a doubt. Why must deference be established as a strategy? Why must it be attached to external sources? Or why, when it has become internalized, is it so often felt to be in conflict with other aspects of the human personality? "Freedom," said Rousseau, "is obedience to the law which we prescribe to ourselves." Authority is the law, or the set of laws, which we definitely do not prescribe to ourselves. There is something of the voice of the strange, of the other, in the voice of authority, no matter how familiar the message may have been. It is the not-we, the not-ourselves that is speaking here, and even where it has become internalized and speaks only in the stillness of our mind, we can still recognize the harshness in its voice. True, we may try to flee to authority when we are discouraged, or desiring to "escape from freedom." But even when we flee to it, we flee to it as one would flee to any port in a storm, and not as one would be going home.

Why do the spokesmen of authority sound so often like men on the defensive — and never more angrily defensive than when they try to copy the posture of attack? Is it not because this specific claim to authority must only be made when it is already on the verge of being questioned?

The specific assertion of authority in an organization, suggests that the distribution of preference and deference is no longer automatically implicit in the pattern of its channels, and that it is no longer automatically accepted by all members. This specific assertion of authority, the ever louder claim for authority, illuminates a situation in which certain operating priorities in a communications system are ceasing to function in certain of its parts in which they are supposed to operate. The more often from then on the voice of authority is heard, the more it will sound like glass that has been cracked. Its very appearance of sturdiness resembles that of the blowout patch that is put on after the tire has been punctured.

The frequent and explicit assertion of authority is often a symptom of a communications system out of order. In the language of A. J. Toynbee, we may expect to find it at the point where a creative minority is changing into a dominant minority, trying to awe or frighten those whom it can no longer charm. Where we have the self-determination of a group or organization which functions well, where social communication and self-government are growing, there freedom and authority may well be much more likely to appear as two equally necessary sides of one and the same process. Even where they appear in conflict under such conditions, theories reconciling them will be popular and frequent; and they will be widely thought successful. Where these conditions do not obtain, where, in the words of W. B. Yeats "the center cannot hold," where the group or organization is going through a period of transformation, there the ever louder assertions of authority cannot restore the harmony that has been lost. The processes of growth and healing here take time, and in the meantime the cry for authority may well change into the cry for naked power.

The number of books on political power is large and ever growing. And yet most of us know, or think we know, what the words, "power," or "power politics," mean when they are used in every day language. Power to most of us means the answer to the questions: "Who is the stronger? Which side in the conflict must give in?"

The concept of power in this usage seems constructed as an analogy to the physicist's notion of hardness. Which material will scratch which other, and not be scratched in turn? Something very much like this seems to be the fundamental notion which underlies most hardness tests. From the result of such tests a hardness scale has been constructed on which all minerals are ranked with the diamond, the hardest of them all.

The hardness scale among minerals finds its curious counterpart in the peck order in the chickenyard. When a new hen is put into the yard, she is pecked at by most of the hens she meets, and may try to peck at each of them in turn. The question to be settled in each of these encounters is the old one: "Which side must give in?" After a few days the "power situation" has been clarified. The new hen has acquired a specific place in the peck order. She will let herself meekly be pecked by hens A, B, C, and D, but may peck with impunity hens F, G, and H. Unlike minerals, however, hens are susceptible creatures, and the outcome of their battles may vary with time, place, and circumstance. As each outcome seems to be remembered, and as hens seem to have more memory than logic, their peck orders are sometimes circular. Hens A to J may peck each other in hierarchical succession, but hen J, the "under hen," may have succeeded in establishing her right to peck hen A.

It may seem a long way from the chickenyard to negotiations between some conflicting interest groups in domestic politics, or to international conferences involving war and peace and touching on points of national honor. Yet, if we listen, we can hear as in an undertone the old refrain: "Who is the stronger? Who must give in?"

The power of an organization is its ability to force another organization to give in. Most organizations have some facilities, primitive or complex, for self-steering. Some of these channels may be visible on the organization chart, others are hidden in the minds of some or all of its members. When two organizations meet head on, each of them tries to substitute directly or indirectly the output of its own steering channels for the output of those of its rival. If a conflict ensues and "pressure is put on," each organization is trying from the outside to operate on the inner steering channels of its enemy. Each may try in effect to destroy the other organization's *integrity*, that is, the intact state of its facilities for self-steering, as well as to destroy its *dignity*, that is, its ability to learn at a non-disruptive rate of speed. On the contrary, as the bitterness increases, the opponent must be pushed for having walked too slowly; his autonomy must be broken as he insisted on defending it; in short, he must be "taught a lesson." The phrase is revealing. There is a dangerous connection between cruelty and a certain kind of teaching. Both are attempts to do violence to the inner processes in an individual or group by operating on them from the outside.

If this seems to be power, can it be achieved? Would this kind of power preserve at least our own autonomy by destroying the autonomy of those groups and individuals standing in our way?

On balance, the answer must be, "No." Power, in the image of the hardness scale and of the chickenyard, would be the power to make the current output of our organization prevail over the current output of all others. If the conflict should be hard, we might have to allocate to its conduct all the disposable resources and all the learning capacity which our organization can muster. But our current output which we are now trying to make prevail, actually was determined by the past of our own system. It was the outcome of the interaction of the memories which our organization had stored and of the past influence which it had received. To make the outcome of this past prevail, may very likely mean to freeze it. In reallocating every ounce of strength that can be recommitted, we may well cut down on our facilities for intake and for inner recall and recombination, that is, we might cut down our sources of new information and of inner novelty. We should be cutting down our receptors and the creative parts of memory, in order to give the effectors all power. What we would be actually doing in this case would be destroying the autonomy and learning capacity of our own organization.

The consequences might become visible even in the power struggle. Our risks might become blind, even though we called them "calculated." There might be increasing breakdowns of intelligence, of the flow of outside information to our side, as well as increasing failures in the evaluation of such intelligence as still comes in. At the same time we might find it increasingly difficult to devise new policies in situations calling for new combinations of ideas. Intelligence and policy making in most organizations depend less on the number of people sitting behind desks, and more on the

quality and the autonomy — the absence of disturbance and the presence of reasonable respect — for the persons and organizations charged with the processing and treatment of such information.

Perhaps such thoughts are not completely academic. In many countries in the world today there seems an inclination to step up the output and let the intake go, to speak rather than to listen, and to shoot rather than to think.

In the long run, such a narrow view of power may not produce power, but rather a caricature of it. A more realistic concept of power could perhaps be developed from the notions of strength and growth. Power, in this broader view, might be based on the ability to *integrate* other things or patterns, both in the worlds of thought and of action. It would involve the ability to mobilize resources, tangible and intangible, from within our organization, as well as from among its neighbors, and to contribute to their resources in turn and on a scale comparable to ours. It would stress the ability to win allies and make them into partners, and ultimately to make partners into something not very unlike fellow citizens.

The problems of freedom, authority, and power might then be looked at as special aspects of the strategy of growth. In major social groups or organizations, intended to endure for longer periods of time, such growth would involve at least four dimensions.

It would involve *economic growth*, that is, the increase in such factors and facilities of production as manpower, capital equipment, land, and specific technological skills and knowledge.

It would involve growth in *autonomy* — A. J. Toynbee's "increase in self-determination" — and hence an increase in all the elements, channels, and facilities which the processes of self-steering and self-government require. This would include an increase in the facilities, tangible and intangible, for inner cohesion among individuals and small organizations within our group, and a corresponding increase in the facilities, tangible and intangible, for the intake of new information from the outside; and it would also include an increase in the internal facilities for communication and steering so as to make the processes of self-steering and of internal rearrangement more powerful and more effective.

All this, in turn, would necessarily involve a growth in *learning capacity*, a growth in the range of goals which organization could pursue, a growth, not merely in the range of external intakes of information, but also in the range of inner initiative and creativity.

Finally, all these would imply a growth in the organization's *range of integration*, that is, an increase in its ability to incorporate within itself patterns, ideas, individuals, and whole sub-organizations, different from itself, without loss of its own identity and yet with a gain toward its own richness and vitality.

What has been said thus far about the growth of organizations, should apply even more to the perhaps even more important and certainly more difficult problem of the growth of individuals. As John Stuart Mill knew so well, the development of a state or an organization is inseparable in the long run from the development of the type of individuals it produces or permits to grow. None of these problems can be discussed in this paper, but it should be clear that they are of crucial importance. In the long run, groups and organizations grow through their individuals or they do not grow at all. All we can say here about this topic is that an organization which is characterized by inner richness and autonomy, by self-awareness and world awareness, and by growing ranges of creativity and integration, should furnish a hospitable home for the development of the type of individuals who would carry on those tasks and who might surpass them in the inner life of their own persons.

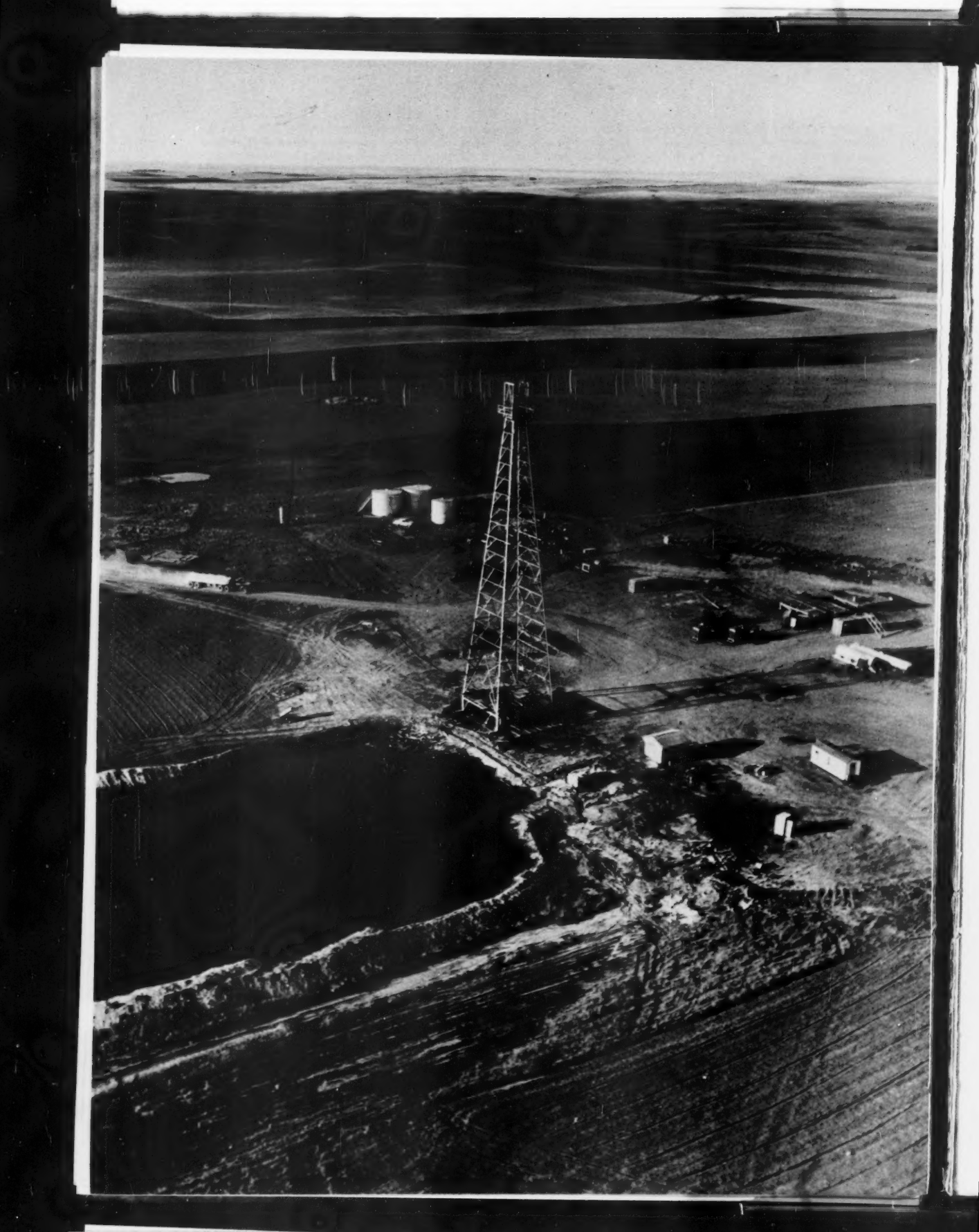
There is perhaps one more question we may still take up. How can an organization increase its range of integration and yet retain its own identity? Our search for an answer may lead us here to one of the most interesting aspects of the theory of communications; to the problem of spirit.

We have often reason to surmise that the word, "spirit," when it is used in a serious sense, has something to do with values, but that it means much more. Perhaps we may try to make this notion more explicit from the viewpoint of communications. While no mind and no organization can operate without values, *spirit* denotes second order value. It is the set of preferences about sets of preferences. A man, a people, or an epoch, all are also value systems; the *spirit* of a man, or a people or an epoch, is the configuration of rules, according to which their value systems are patterned and operated. Spirit is related to values as strategy to tactics, or as policy to operations. A change in "spirit" means, therefore, a strategic change in the patterns of behavior. And, under suitable conditions, it can be communicated.

As it is second order value, the notion of spirit, and indeed the strategic value pattern of spirit, can be communicated beyond the confines of the original value system from which it was abstracted. It may thus suggest a framework and a strategy for the integration of several different value systems which on their own level partly contradict each other. At the same time, spirit does not need to touch the first order value systems at every single point; and it may, on the other hand, include second order abstractions from other ranges of value and experience which may be quite unfamiliar to most of the individuals in every one of the constituent first order groups or cultures which it has helped to integrate. Spirit, in other words, is capable of being received and of aiding effectively in bringing about major changes; but it need not be capable of being exhausted.

What has been suggested here in analytical language may perhaps be more familiar in another guise from the data of history. The great styles of art and of music and the great religions of the world have demonstrated, not once but many times, that a pattern of spirit can transcend the limits of individuals, organizations, groups, and cultures. Starting from one of these carriers, or carried by several of them in conjunction, each of these great strategies of value transcended the region that gave them birth, and transformed themselves in the process.

We have around us the inescapable evidence that these things happened in the past. We have perhaps for the first time a chance at making a very weak and tentative beginning at understanding at least a few of the aspects of the process; and we have before us the tremendous storehouse of the world's living traditions of ethics, philosophy, and of religion. We know that time and again a spirit of integration has characterized some period in the past. Perhaps there is good reason to believe that it can happen again.



"black gold" galore

Williston Oil Basin: A Rival for Texas?

By George B. Raymond '55

On April 5, 1951, the drill of a wildcat rig near Tioga, North Dakota, brought to the surface the object of thirty years of geological study and research — positive proof of the existence of a vast oil deposit in the Williston Basin. The Amerada Petroleum Company's discovery touched off one of the greatest oil booms of the century.

A year earlier a strike had been made further north of Tioga in Manitoba, which is included in the Canadian section of the basin. The Amerada discovery was the first to be made in the United States, but of even greater importance was the fact that the location of the new strike is approximately two hundred miles from the Manitoba one. If the two are part of the same formation, the existence and development of an oil region three hundred miles wide and four hundred miles long is now a definite possibility.

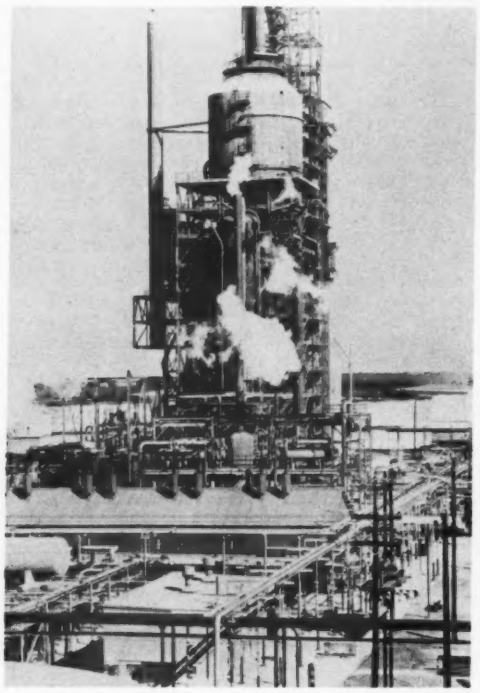
Previous to the Tioga find, dozens of unsuccessful wells had been drilled throughout the area. The "Nesson Anticline," an inverted saucerlike twenty by thirty mile "bump" on the earth's surface, was known as early as 1923, and it was on this "bump" that the first successful well was sunk. In 1941 the American Association of Petroleum Geologists released a report describing the Williston Basin in considerable geological detail and containing complete cross sectional maps. The Standard Oil Company of California had drilled as far down as 10,281 feet, in 1938, without gaining anything but experience. This dry well was located just five miles from Amerada's big find. However, when the size of this potential oil-producing region is taken into consideration, it is no surprise that the first oil has been found only within the last two years. The area of the entire region is about one hundred thousand square miles, while the area of the oil fields themselves is no more than a few thousand acres. Last year, ten thousand wells were sunk throughout the United States, the average cost of each was ninety thousand dollars. Of the total number of wells sunk, only seventeen per cent were successful.

Thirty miles northwest of Williston, North Dakota, they have developed the most successful field of the entire region — the Beaver Lodge Pool. Here, Amerada has completed a dozen wells with more planned for the future. Not only is the quantity yield of this particular field high, but also, the quality of the oil is generally higher than that of other producing fields. Although there are at present less than a hundred wells at Beaver Lodge Pool, future plans provide for drillings that will bring the total number of wells up to a maximum of six hundred and twenty-five. Amerada is by no means the only company in the Basin. More than fifty other companies, thirty of which are major producers, are exploring the region. Soon after the first strike, Shell Oil met with success in eastern Montana, where four fields are in full-scale operation. One of these, in the Poplar Area, grew out of a strike on the Fort Peck Indian Reservation by the Murphy Corporation. Also of major interest are the other regions on the Canadian side of the Basin. In southern Saskatchewan, near Fosterton, Socony-

Vacuum and Woodly Petroleum Corporation have a small but rapidly developing field. Even though Standard Oil of California missed the achievements of Amerada by six miles and fourteen years, they now have a producing field in the southwestern corner of Manitoba.

Wildcatting is widespread. Because of the diversity of existing fields experienced oil hunters firmly believe that hundreds of other oil-producing areas will soon fill up the existing "holes of speculation" that now dot the basin. Some companies have pulled oil rigs out of the Southwest for exploration purposes. Currently over a hundred geophysical crews, representing twenty per cent of the United States total, are measuring effects which they hope will point out the surface locations and depth of new sources. With their seismic, magnetic, and gravimetric methods they locate a likely spot; the wildcat rig moves in and drilling begins. If oil is not found, the operation is a complete loss of time and money — one hundred thousand dollars or more. A dry hole is the rule; an oil well, the exception. The only gain is in the knowledge that there is no oil in the particular area, at least within two or three miles.

A lack of refineries slows development, but still . . .



Nearly everybody in N. D. hunts for oil, or . . .

Builds a derrick!

One important difference has been found between the United States and Canadian deposits. The average depth of the fields now producing in North Dakota is about eight thousand feet. The Canadian fields are relatively shallow at two thousand, two hundred feet. This shallowness cuts down the drilling costs in these areas tremendously. It is hoped that the geological characteristics, which make the more shallow wells possible, may extend all along the eastern rim of the Basin and down into North Dakota. A recent Canadian discovery only a few miles from North Dakota has strengthened these hopes considerably.

The new oil industry may give the needed economic stimulus to the development of this area of the United States. Until the oil industry moved in, the only visible signs of livelihood were acres of wheat interrupted only by the agriculturally unproductive "Bad Lands." Now thousands of people are pouring into this area to help extract the long dormant wealth of natural resources.

The region has a long way to go, however, before it will become another Texas. The main problem that confronts its developers at present is that of getting the crude oil to refineries. No pipeline exists. The oil must be shipped by rail to the West Coast or back to the small refinery facilities of the Middle West. If the present rate of growth continues, a pipeline to the Saint Paul-Minneapolis district seems inevitable. But before this can be accomplished the Williston Basin must be firmly established as a major oil-producing region.

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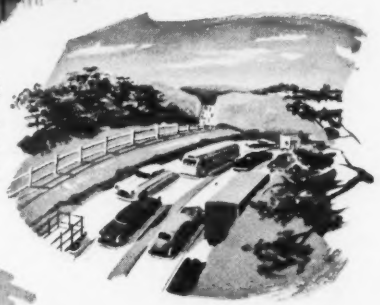

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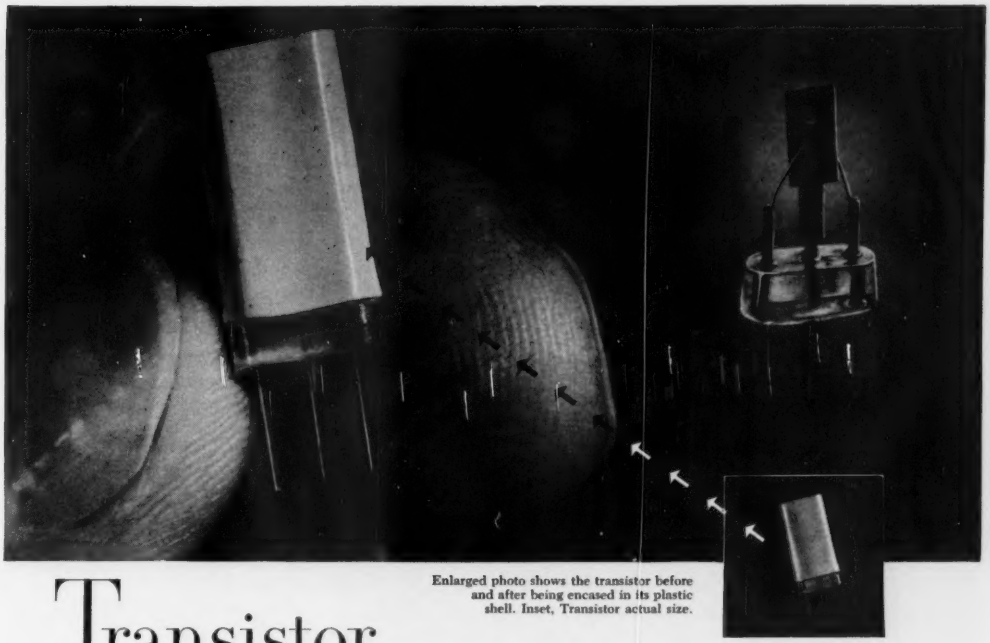

Enlarged photo shows the transistor before and after being encased in its plastic shell. Inset, Transistor actual size.

Transistor—

mighty mite of electronics

Because of growing public interest in transistors, RCA—a pioneer in their development for practical use in electronics—answers some basic questions:

Q: ***What is a transistor?***

A: The transistor consists of a small particle of the metal germanium imbedded in a plastic shell about the size of a kernel of corn. It controls electrons in solids in much the same way that the electron tube handles electrons in a vacuum. But transistors are not interchangeable with tubes in the sense that a tube can be removed from a radio or television set and a transistor substituted. New circuits and components are needed.

Q: ***What is germanium?***

A: Germanium is a metal midway between gold and platinum in cost, but a penny or two will buy the amount needed for one transistor. Germanium is one of the basic elements found in coal and certain ores. When painstakingly prepared, it has unusual electrical characteristics which enable a transistor to detect, amplify and oscillate as does an electron tube.

Q: ***What are the advantages of transistors?***

A: They have no heated filament, require no warm-up, and use little power. They are rugged, shock-resistant and unaffected by dampness. They have long life. These qualities offer great opportunities for the miniaturization, simplification, and refinement of many types of electronic equipment.

Q: ***What is the present status of transistors?***

A: There are a number of types, most still in the development stage. RCA has demonstrated to 200 electronics firms—plus Armed Forces representatives—how transistors could be used in many different applications.

Q: ***How widely will the transistor be used in the future?***

A: To indicate future applications, RCA scientists have demonstrated *experimental* transistorized amplifiers, phonographs, radio receivers (AM, FM, and automobile), tiny transmitters, and a number of television circuits. Because of its physical characteristics, the transistor qualifies superbly for use in lightweight, portable instruments.

* * *

RCA scientists, research men and engineers, aided by increased laboratory facilities, have intensified their work in the field of transistors. New applications in both military and commercial fields are being studied. Already the transistor gives evidence that it will greatly extend the base of the electronics art into many new fields of science, commerce and industry. Such pioneering assures finer performance from any product or service trade-marked RCA and RCA Victor.

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WHERE YOU WORK

After your period of training—at full pay—you may (1) remain with the Laboratories in Southern California in an instructive or administrative capacity, (2) become the Hughes representative at a company where our equipment is being installed, or (3) be the Hughes representative at a military base in this country—or overseas (single men only). Compensation is made for traveling and moving household effects, and married men keep their families with them at all times.

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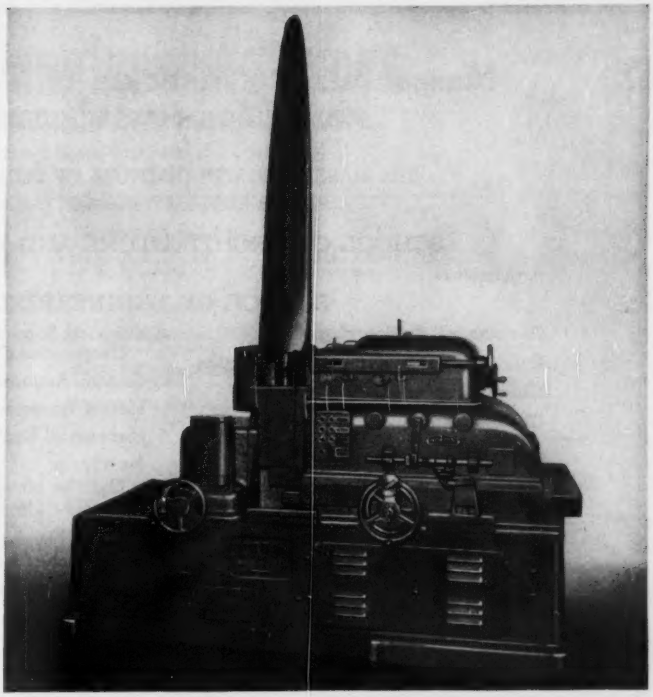
- ☐ *a vertical miller*
- ☐ *a grinding machine*
- ☐ *a broaching machine*
- ☐ *a contour shaper*



It is a grinding machine — specifically, the new Norton Propeller Blade Hub Grinder, used to grind the external surfaces of the hubs of aircraft propeller blades

A Typical Norton Development

This specialized Norton machine brings unusual efficiency to propeller grinding operations. As shown, the propeller blade is held *vertically* — by a workholding fixture on a work spindle with an anti-friction bearing — a new departure that avoids the errors normally caused by deflection when the blade is held *horizontally*, as in conventional methods.

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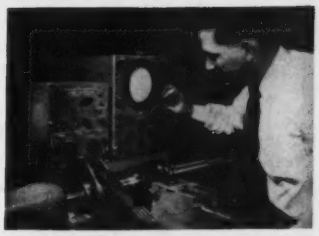

Guy D. Metcalf, B. S., E. E., Worcester Polytechnic Institute '49, checks smoothness of master cam spindle with specially designed electronic equipment — in connection with his work on Norton cam and contour grinders.

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tech engineering news

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* See Page 21.

from the editor's notebook

Take Time to Look Around You

Everyone today seems to be busy. We all scurry from class to class absorbed in the current crises in our lives (i.e., the next 5.02 quiz). Yet we could get much extra enjoyment out of our days at Tech with no additional drain on our time. How? By seeing and appreciating the common sights around us every day. Spring makes them even more beautiful than usual.

Once we are looking for beauty about us we find it on all sides. Don't merely glance across the Charles tomorrow to see if Boston has disappeared overnight; take time to really look across the river. On these delightful spring days the city seems to be basking in the warmth of the sun. The dome of the State House glistens in the bright air, and the shiny reflections from the slate roofs are reflected in the river. Notice how gracefully a sea gull can alight on the water. When you walk through the Great Court between classes, stop to observe how impressive even the Institute is on a spring day. The white flowers seem so fresh after the somber winter greys; the green buds give the trees a touch of welcome color. In the evening, the sunset colors the Charles with hundreds of deep red, gold, and purple reflections. After looking at such a scene one forgets the cares of the day which had seemed so important only a few minutes before.

At the cost of a day or less one can get a picture of New England that can never be forgotten. Have you ever seen the beautiful apple orchards, nestled in quiet valleys of green meadows? They are within a few hours' hitchhiking distance of Tech. On the outskirts of Boston there are many parks and lakes which are extremely beautiful if we only take a few hours to visit them.

Probably last winter's weather was tiresome and depressing. Perhaps the months crept by with seemingly endless rain, snow, or cold, although we might remember the sight of brilliant sunlight on fresh snow. At any rate the winter serves to make a New England spring even more welcome and makes us appreciate the world around us a little more. Or rather we would appreciate it if we would take a few seconds to notice it. J. M.

The New Managing Board for Next Year Selected

The new Managing Board for *T. E. N.* will be composed of Pete Embree '54, General Manager; Don Eckhardt '55, Editor-in-Chief; Ray D'Arcy '54, Business Manager; and Herb Jacobson '54, Managing Editor. These worthy men are already hard at work on the October issue.

What's Happening at CRUCIBLE

about tool steel forgings

Whether 1½ pounds or 7 tons . . . forgings get the same sensitive handling

Crucible's reputation as the specialty steel leader is built on a devotion to the smallest detail . . . regardless of the size of the order.

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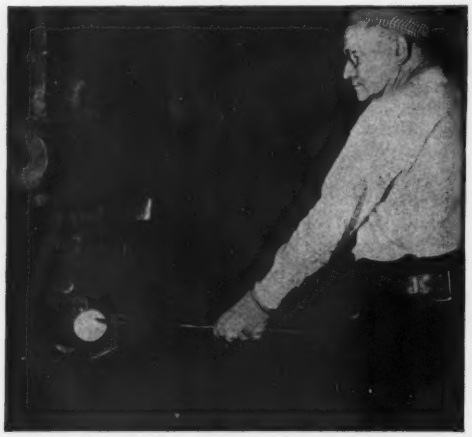
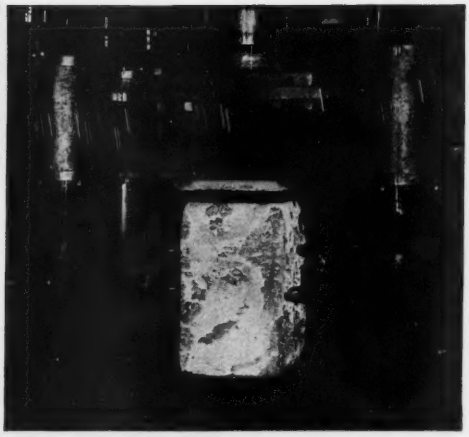
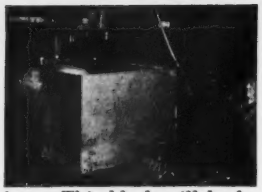


Rex M-2 High Speed Steel Disc Forging (1½ pounds)

Pancake forgings such as these are used extensively by small tool makers. Extreme care is taken in the preparation of the slug stock. The upsetting insures proper flow lines. Milling cutters, gear shavers and similar cutting tools that require maximum toughness, coupled with the best cutting ability, are made from these forgings.





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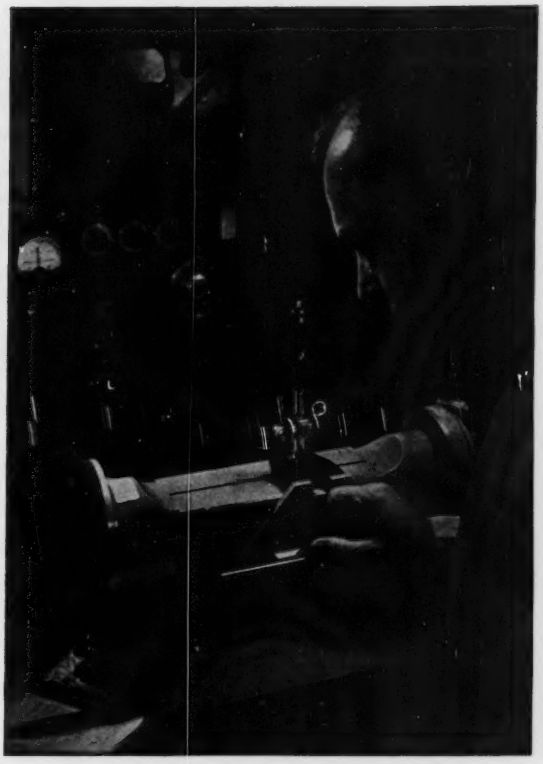

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Choice of line length is equally pre-set. Maximum stored for justification before the completed line is put

photon

A Revolution in the Printing and Publishing Industry

On the fifth of February, the first book set by a revolutionary typesetting machine was presented to the Massachusetts Institute of Technology. The Charles Hayden Memorial Library, and the Faculty Club, have both had the book on exhibition. It is hoped that those who have looked at the display have recognized an amazing development. Dr. Vannevar Bush, in presenting this book, said that it represented a milestone in the arch of civilization — a new approach in the problem of placing one man's thoughts at another man's disposal. It is with the hope of elucidating this "milestone" that this article is written.

For over five hundred years movable type has been the tradition and the basis of printing, and its invention, credited to Gutenberg, has been hailed as one of man's greatest inventions. The first book printed from movable type, the famous Gutenberg Bible, has become a rare collectors' item.

Until late in the nineteenth century all metal type was set by hand. The Linotype, in 1885, and the Monotype, in 1887, provided equipment for the casting of type by keyboard operation. Today these three methods remain the accepted ways for composing type.

In 1949, the Graphic Arts Research Foundation, Inc. of Cambridge, Massachusetts was formed to provide high-level research in the printing industry. It has as its objective the creation of new, better and less costly printing methods. In the Higonnet-Moyroud, or Photon, photographic type-composing machine — its first project — the Foundation has perfected an entirely new, faster and far more versatile means of composition which does not employ metal type.

If time proves the Photon to be the replacement for past typesetting methods, then the printing and publishing industry is on the threshold of a new era.

The machine, as yet unnamed, although variously known as Lumitype, Lithomat, or Photon, offers all that can be asked for in the advance of typesetting techniques. In keeping with the purpose of the Graphic Arts Research Foundation, Inc., its originator, the machine is no mere improvement or better control of existing methods, but rather the result of a research project directed toward fundamental change in typesetting techniques. From the outside it is a desk topped with an electric typewriter, but within its unassuming metal cabinet there is a relay system similar to the time-tested telephone's relay selectivity circuits, a binary code mathematic system reminiscent of monstrous calculating machines, and electronic devices as seen by mortals in automatic door openers.

Simple, audible control devices, such as might be put to use on present slug casting equipment, augment the push button system which characterizes the control of type selection, size, set, leading, flush left, flush right, center, correction, etc., as follows: The choice of type is quite wide. Sixteen complete fonts (a complete assortment of types of one size and face) of type are at the operator's fingertips in a panel of buttons placed to the right of the typewriter. Even in the process of setting a line the operator can push buttons to change from one font to another without further complications. Moreover, a change to another sixteen font matrix can be effected by replacing the one and a half pound glass disc within the machine, a process which is said to take one minute.

With four extra keys added to the usual keyboard arrangement of 42 keys, the operator has 8 extra symbols within each alphabet, a total of 92, at her disposal.

Choice of leading (spacing between lines) can be selected from 0 to 24 points by increments as small as ½ point. A point is a printing measure equivalent to 1/72 of an inch.

Choice of point size ranges from 5–36 point. There are twelve choices within this range in which any of the 1,440 characters available in one matrix can be produced. In total, there are 17,280 combinations in character and point size at the operator's fingertips — or 16 alphabets in 12 sizes for a total of 192 different alphabets.

Choice of point set (type body width) can be set independently of point size. This feature permits the overlapping of characters which normally can be accomplished only by the use of kerned type.

Dr. Karl T. Compton accepts the first book for the M. I. T. libraries.

Exhibition at the M. I. T. Faculty Club.

Choice of line length is equally pre-set. Maximum line measure seven inches, the limit of film width.

The fifth row in contrast to the typewriter's usual four banks of keys, provide for (*a*) correction of individual character errors, (*b*) elimination of entire line, (*c*) automatic centering, (*d*) insertion of fixed spacing of varying width, (*e*) automatic right and left quadding, and (*f*) the production of justified and non-justified lines. Justification is used to make lines of exact length. This may be done by spacing between or within words, or at the ends of lines.

A correction key provides for correcting single letters. The erasure within the machine is automatic. Too many errors within a line are eliminated with another key which erases all the composition within the line.

Choice of flush left, flush right, and centering is controlled by a key for each selection. Flush left and right can be used simultaneously, as in telephone composition, with the machine filling in leaders automatically.

Carriage return and advance of platen after completing a line is also controlled by fingertip key control; simultaneously the typed line is released to machine controls.

A line counter is provided. Thus setting folios, running heads, and chapter heads can be accomplished without error.

A dial provided at eye level indicates graphically how much space on the line has been used and how much is left. The dial rarely needs attention in straight composition because audible signals have been devised to augment its function.

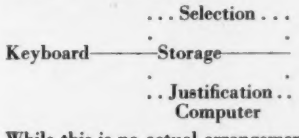
A gong sounds when composition approaches justification range. Thereafter a buzzer intones the area of most satisfactory justification. At the point where the available line length has been used up, the buzzer stops, indicating overset. The automatic backspacer can be used to eliminate overset.

With these controls every family, size or style available at the operator's keyboard may be placed in the line being composed. Not only can type styles be mixed within a line, but point sizes, point sets and families may also be mixed without interfering with justification or alignment. The result looks as clean and sharp as the best type composition known today, but reveals nothing of the speed and economy that had been effected in the performance.

Speed is controlled only by the typist's ability to operate an electric typewriter. Ten book pages an hour is estimated to be a good average. A Graphic Arts Foundation engineer using his two finger hunt-and-peck system managed one page every six minutes.

The product of the machine may either be developed as a positive or negative galley. Film length is 100 feet. Replacement of film can be performed by the operator.

Briefly and very elementarily, the Photon, or Higonnet-Moyroud, photo composing machine derives its versatility and ease of operation from a system that functions basically like this:



While this is no actual arrangement nor representative of the complex control mechanism, basic features are shown. Instead of feeding characters directly to the photographic unit, it is necessary to introduce a storage unit where the characters, words and spaces may be stored for justification before the completed line is put to film.

The storage unit may be characterized physically as a "pegboard," *mentally* as a "memory bank." For each horizontal escapement of the typewriter roller platen there are nine vertically spaced pegholes. The "pegs" or pins in the board may be pushed either in or out.

Since each key on the typewriter has its own code represented in open and closed electrical circuits, a key when struck, will push out its combination of displaced and undisplaced pins within the nine-hole vertical column. Each character is thus identified by a nine-element code which is in reality a nine-digit binary number. Five digits indicate the width of the character and four are used to distinguish the character from others of the same width.

M. I. T.'s Professor Samuel H. Caldwell, director of GARF research, gave the following example of the code in his article on the technical features of the machine: "If an open contact represents zero and a closed contact represents one, a typical character might have the code number 010010111 when written in binary form. If the first five digits represent the character width this number expressed in the decimal system would be 9-7, and it would mean that this character is nine units wide and that it is character number seven of that width."

Glorified typewriter: the photo-composing machine.

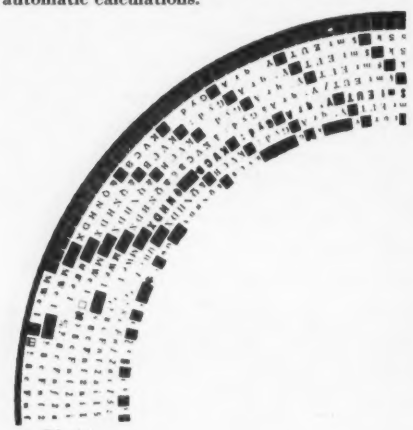
Every family, size or style available at the operator's keyboard *may be placed* in the line being composed. Not only can type styles **be mixed within a line,** but point sizes and families may also be mixed **without interfering** with justification or alignment

Fourteen Twelve Eleven Ten Nine Eight Seven Six
MMMMMMMMMMMMMMMMMMMMMM

Being a reproduction of a reproduction and thus not perfect, these sample types produced on a pre-production model of the Photon machine are merely shown to illustrate the many changes that can be accomplished within a line of type by merely pushing buttons. No time is lost in composing these 10 styles in 7 sizes. Illustration at top of page shows production model of machine. Twelve are now under construction, with a hundred more planned as a starter.

Selection as to style, size, set, etc., determined prior to actuating the character keys, is also taken into account by the pegboard. If selection is changed within the line, the machine automatically registers this information with the next available row of vertical pins so as to forewarn the decoding mechanism of the change.

The justification counter keeps a running account of the line used up. It registers each interword space while accumulating the space requirements for each character. When justifying, the interword spaces are proportionately divided between words. Telephone stepping switches, 136 relays and other circuitry, much "simpler" than the 3,000 to 5,000 components usually employed in telephone set-ups, help engineer these automatic calculations.



A quarter portion of the revolving glass disc shows how characters are placed in eight rows. There is only a single character of each family and style. Each circle contains two full fonts arranged in a semi-circle. Thus, one matrix contains sixteen fonts or about 1400 basic characters. The disc measures eight inches in diameter.

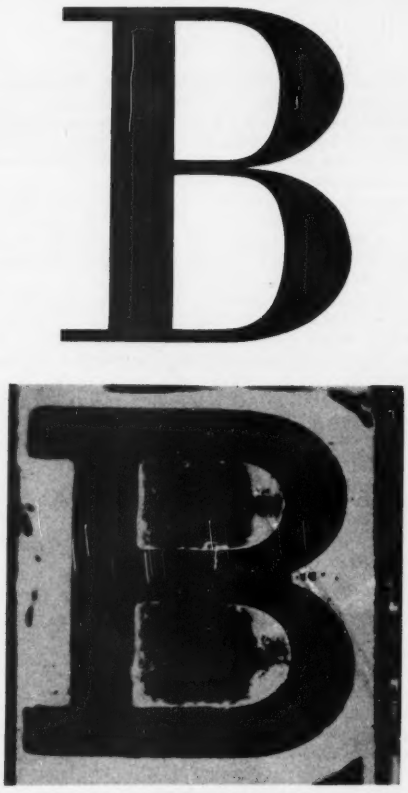
The decoding unit represents a carriage combing vertically across the pegboard. On sensing each projecting pin, it closes contact and re-interprets the original coded description of the character back into electrical impulse strength.

The photographing unit features the rotating glass disc, 8 inches in diameter, which is the matrix for 1,400 characters grouped in eight concentric circles, with each half circle containing a font. The slits at the periphery help to register each minute matrix letter image in exact position for photographing as follows:

The disc's uninterrupted rotation is synchronized with the rotation of a commutator. Brushes over the commutator drum charged with electrical impulses received from the carriage will upon reaching a point on the drum sensitive to that impulse actuate a photocell and a stroboscopic light. It fires with a microsecond flash to "stop" the picture of the matrix image on the film.

The electrical impulse from the commutator also dictates horizontal and vertical spacing. After each photographing operation the disc makes one-half blank revolution for this spacing to take place.

To the uninitiated it is inconceivable to imagine the speed with which these intricate operations are



Photon is proud of its type design. Top, a typical Photon master character of the latest type. Below, a twelve-point metal character enlarged forty times, but reduced again in photo-engraving one-half.

performed. The typist meanwhile is continuing her work without interruption.

A statistical analysis of machine operation, naturally not based on actual but theoretical working conditions, reveals that many savings are in store for the user of the photo composing machine. Some proponents claim a cost saving of one-half over metal composition costs. Such savings would not only be attributable to the speed of the machine or the possibility of paying lower wages in its operation, but also on such other factors as the matrix's versatility.

Actually one simple glass disc contains the equivalent of $25,000 worth of matrices. The operator controls 128 fonts from the use of one disc. Nor is there any wear or tear on the matrix. The same disc can be used indefinitely.

To duplicate the variety of a single disc on a type casting machine would require 96 magazines (part of conventional composing machine in which the letters are stored, ready to be assembled into lines) of two-character mats at a cost of well over $25,000. The weight would be in excess of 4,000 pounds and more than 90 cubic feet of storage space would be required. The disc weighs only 1½ pounds. Also, unlike type casting machines, the photo composer's "single-character" system eliminates mat sorting.

Photo composition has more flexibility in makeup. Without committing the designer's idea to expensive metal type, film can show the projected appearance of

the design in type at minimum cost — and minimum cost of alteration. All the elements in a page-design can be rapidly assembled on an illuminated frame where the layout proportions are visible right under the film where the type is being arranged. The film need not be fastened but merely positioned or repositioned for better effect.

If the page has been "made-up" in such a manner photographic proofs can be "pulled" on an Ozalid machine. This machine makes dry prints from transparencies at a high rate of speed and costing an estimated one cent per print. Proofs are then available for approval of all concerned. Only then, upon final approval, is the page released for engraving.

In this atmosphere Photon has rallied all the exactitude of science in a successful effort to produce the truest possible reproduction of type design on the matrix, a job worthy of a type designer's fondest dreams.

Starting from a seven-point lead cast character, spanned into an eight-foot tall contraption of lenses, mirrors, and lights, the typographic image, magnified almost to five hundred points, is projected to paper for tracing. In return a geometrical reconstruction of the character's face eliminates the irregular shaping with its nooks and crannies, the faulty tooling, the inevitable batters inherent to metal type. The true shape is thus restored in black ink drawing on white paper, enlarged for photographing.

To insure correct spacing of characters Photon threw aside all known formulas and set out on a survey of its own. Analyzing scores of book pages, newspaper articles, and advertising copy statistically, a chart was compiled to show with what frequency each character in the alphabet is associated with other characters in the alphabet. While, for instance, a *Qj* combination never occurs, a card for the letter *e* showed with what frequency this letter was associated with others in the alphabet. The result of this survey determined the position of each letter on the matrix.

Making the actual matrix involves an arrangement of camera, lights, and automatic controls to project these letter designs to the glass disc in proper sequence and position. The black screen at one end of the room, with the camera in the opposite wall, represents an enlargement of the matrix (see illustration). The letters are arranged along an enlarged curvature, proportionate to the matrix radius. After every photographing sequence the matrix is automatically indexed in the camera sufficiently to allow for the next set of characters to appear which are placed into position by handlers behind the screen. The sequence of letters is controlled by the man sitting in front of the screen.

The slit visible above the curvature on the screen will appear as the register slit on the matrix.

For most type design it has been necessary to make two sets of matrices, one for small sizes, the other for sizes above twelve point, because optical enlargement of the smaller character within the machine would distort its designed shape. In other cases one design has sufficed, while a few dictated three gradations.

While it takes more than a hour to photograph one disc, duplicates are produced within minutes. The expense for matrices is thus kept at minimum.

With film as a medium, type need no longer be confined to the limits of a metal body. Released from these limitations new type designs would indeed be ideal, but no matter how forward looking a research organization might be it must sell a product currently marketable. To this end current matrix production is confined to popular type designs, but the door is open for a new era in type design.

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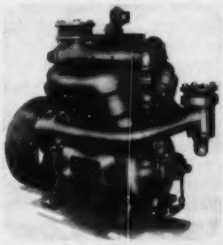

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cooperatives, labor unions, and you

By Howard J. Simmons, '54

Due to overlapping, and the multiplicity of functions performed by any given cooperative association, it would be impossible to strictly define classes of cooperatives so that each cooperative would fall into only one of them. In general, however, it is possible to divide the cooperatives into two groups. First there is the consumer union which is very much like the labor union, in that it attempts to organize an existing group in the society and thereby increase the power of this group. The primary function of the consumer union is to concentrate the buying power of many families into one powerful block which can, to some extent, help regulate prices. Like the labor union its power is primarily one of resistance; that is, being a necessary component of the private enterprise system, the consumer union is able to curtail its activity in the system until conditions are made more favorable to its members. An element of thrift is also introduced, since the consumer unions are able to dispense with the retail middleman and his profits. The second general grouping of the cooperatives is the marketing and production cooperatives which differ from the first class in that they are attempting to create a new force in the economy. In these groups the source of capital and investment are, as an ideal situation, identical. As a result the profits of the industry go only to the workers of that industry. These definitions are idealizations of the actual cases, but will serve to give the reader a general notion of the types of cooperatives that have grown up in the United States and to a greater extent in other nations, particularly in Sweden.

Before proceeding to the problem of job opportunities, we will first examine the extent to which the cooperatives enter into our national economic life. As a general rule the consumer unions are strongest and biggest in the rural areas. In recent years, however, the rural consumer unions have been opening their ranks to the urban residents. There are signs that this marriage between the farmer and the factory worker may develop into a profitable venture for both. The development of cooperatives of the second type has been largely confined to the area of marketing rather than that of industrial production. Once again it is the farmer that is taking the lead. In fact, there is only one other marketing and production cooperative doing sufficient business to warrant mention in the U. S. Department of Commerce Statistical Abstract for 1952. This is the electrical power cooperatives. The figures given in table are in some ways deceiving, since, in spite of the apparent equality of power systems, in 1949 private electric utilities produced about 80 per cent of the nation's power and the cooperative utilities produced about 1.9 per cent. The rest was provided by government, public authorities, and industrial power systems. A casual review of the tables shown here will show much better than words can that as far as bigness goes (cooperatives did about 1% of the nation's business), the cooperatives are hardly worth consideration. However, in terms of growth and the spirit of the membership, the cooperative movement is certainly strong. The future looks extremely bright.

Having once grasped the scope of the cooperative movement in the United States, we can now move on to the problem of jobs for college graduates. The national organization of Students for Democratic Action, in an attempt to find out to what extent college graduates may obtain jobs within the cooperative and labor union movements, sent out letters to the various cooperatives and labor unions in the United States. We have reprinted the two most representative replies from the cooperatives and labor unions below.

Replies to Inquiries Sent to Cooperative and Trade Union Organizations

Cooperatives

Central Cooperative Wholesale
Superior, Wisconsin

"We are pleased to see your interest in the possibilities of employment in cooperatives. . . .

"Most of the people in responsible positions with our organization or our affiliated local cooperatives have come up through the organization, but we do have a number of college graduates. . . .

"For the future we anticipate that the principal openings will be with the local retail cooperatives, particularly in the field of management. We continue to have a need for capable people who will be willing to step into positions that will provide training aimed at ultimately making managers of the trainees. Such people will generally have to enter into cooperative employment in the positions of clerk or perhaps assistant bookkeeper. They can then work their way up into department management and finally into general management of a local association. In the field of management itself they will usually move up from a smaller organization into progressively larger ones.

"For management positions college students should have training in business administration. That could perhaps be their major with minors in economics, sociology, and agricultural economics. The agricultural economics is important for the reason that cooperatives in our area, as well as elsewhere, are largely centered in rural areas. Although our cooperatives are consumer organizations, the bulk of our membership are farmers and own small farms at that.

"There are a few other positions occasionally open in which graduates with other majors can fit. For instance, psychology, education and the social sciences are helpful in educational and journalistic work in cooperatives. It is not often we have this type of opening in our particular area but they do occur once in a great while."

H. O. Sanders,
Personnel Director.

MEMBERSHIP AND BUSINESS OF COOPERATIVES 1950

TYPE OF ASSOCIATION	NO. OF ASSNS.	NO. OF MEMBERS (1,000)	AMT. OF BUSINESS ($ 1,000)
Local Associations			
Retail distributive	3,235	2,642	1,253,500
Services - medical, housing, burial, storage, etc.	779	344	41,281
Electric light and power	906	3,250	219,000
Telephone	33,000	675	10,000
Credit unions	10,580	4,609	995,960
Insurance associations	2,000	11,750	210,250
Federations		MEMBER ASSNS.	
Wholesale:			
Interegional	2	77	10,532
Regional	30	4,992	439,250
District	20	280	7,060
Services	18	1,135	2,299
Productive	15	402	82,308
Electric light and power	15	109	11,900

The tables shown here have been selected to show the growth and present strength of the cooperative movement. Also, in the case of the utility tables, one should note not only the comparative growths of the private, public, and cooperative utilities, but also the manner in which the private utilities have grown.

Farmers' Marketing and Purchasing Associations: Number, Membership, and Business - 1913 to 1950

YEAR	ASSOCIATIONS NO.			MEMBERSHIP ESTIMATED			BUSINESS ($ 1,00)		
	TOTAL	MARKET	PURCHASE	TOTAL	MARKET	PURCHASE	TOTAL	MARKET	PURCHASE
1915	5,424	5,149	275	651,186	591,683	59,503	635,839	624,161	11,678
1925-26	10,803	9,586	1,217	2,700,000	2,453,000	247,000	2,400,000	2,265,000	135,000
1934-35	10,700	8,794	1,906	3,280,000	2,490,000	790,000	1,530,000	1,343,000	187,000
1941-42	10,550	7,824	2,726	3,600,000	2,430,000	1,170,000	2,840,000	2,360,000	480,000
1944-45	10,150	7,400	2,750	4,505,000	2,895,000	1,610,000	5,645,000	4,835,000	810,000
1949-50	10,035	6,922	3,113	6,584,000	4,075,000	2,509,000	8,726,000	7,082,600	1,643,400

Electric Utilities: Number and Ownership
1922 - 1950

Year and data divisions	Total all systems	Privately owned	Publicly Owned				
			Total	Municipal	Federal	District & State proj.	COOPERATIVES
1922: Total electric supply systems	6,355	3,774	2,581	2,581			
Number of generating plants	5,444	3,615	1,829	1,829			
1932: Total electric supply systems	3,429	1,627	1,802	1,799	3		
Number of generating plants	4,339	3,244	1,095	1,685	10		
1945: Total electric supply systems	4,051	1,060	2,991	2,092	74	25	800
Number of generating plants	3,886	2,400	1,486	1,157	86	101	142
1950: Total electric supply systems	4,007	821	3,186	2,077	55	91	963
Number of generating plants	3,867	2,334	1,533	1,136	83	148	166

Consumers Cooperative Association
P. O. Box, No. 2359
Kansas City 13, Missouri

"Our organization does employ college graduates on many different types of jobs, primarily, however, on accounting, sales training, clerical, training for management of local cooperatives, and some geological and refinery positions. Undoubtedly we will have openings in most all of these fields during the next few years . . . training and experience in the field of endeavor for which the individual is being considered are always desirable.

"At this time I would not be too encouraging with regard to opportunities for people just coming out of college in any of the fields you mention, such as research, educational, journalistic, and organizational work. We occasionally do have such openings, but they are not too frequent."

STANLEY L. ANDERSON.
Employment Manager.

American Federation of State, County, and Municipal Employees, A.F. of L.
Federation Building
Madison 1, Wisconsin

"We have found that there is a need for young college trained men because of the very nature of our type of organizing and business agent work. Our representatives must be qualified to meet with members of city councils, county boards, and do lobbying work in state legislatures. Negotiating in an atmosphere in which legal sanctions do not protect a public employee is difficult and requires an individual with more than a trade union background.

"We are looking for men to fill vacancies as organizers and representatives of our state and district councils throughout the country. The work of these organizers is about 50 per cent organizing and 50 per cent handling grievances and in representing locals before legislative bodies.

"We like to have people who have had experience in the public service but even if they have not had it we want capable individuals with college training with a labor background or in the field of public administration. Many of our council representatives are employed directly by the councils without any training through the international office. Recently the international has attempted to train individuals for placement with councils and this program brings the men into international headquarters for a period of ten days or two weeks. This is followed by a training period with one or more of our field staff, depending on the experience of the individual trainee."

HENRY T. WILSON,
Administrative Assistant.

American Federation of Teachers, A.F. of L.
28 East Jackson Boulevard
Chicago 4, Illinois

". . . With very rare exceptions do we ever employ other than those who have come up through our ranks. We are quite jealous of experience in the field of teaching itself and that becomes a prime requisite when we are employing people. Most of our activities are concerned with journalism and organizing."

JOHN M. EKLUND,
President.

Distillery, Rectifying and Wine Workers' International Union of America, A.F. of L.
320 South Ashland Boulevard
Chicago 7, Illinois

"This International Union and its locals *does* employ college graduates who have not come up through the ranks of the union. . . . There will be openings in the next few years for qualified personnel in the organizing, political action, research, and journalistic activities of this organization.

"The type of training and experience most desirable from applicants would be: (a) A thorough knowledge of the requirements and processes of the NLRB, which would enable a new organizer to properly lay the ground work for an organizing campaign. (b) Public speaking ability is a very necessary requirement. (c) A thorough study should be made of the industry or industries the student expects to specialize in (coal mining industry, distilling industry, etc.) so that they will at least have a working knowledge of job classifications, procedures, etc. (d) Leadership development would be aided and abetted by knowledge of the above subjects giving the new organizer confidence in himself so that he may impart it to others, because it has been proven time and again that knowledge itself is not enough. The ability to transmit it to others is most necessary in leadership development."

JOSEPH O'NEILL,
General President.

VIRGIL BURTZ,
Director, Research and Education.
Oil Workers International Union, C. I. O.
1840 California Street
Denver 2, Colorado

"We have only two departments in which there is any possibility at any time of employment of students just out of college, and each of these departments consists of only two staff members. I am referring to our publicity department and our research and education department.

"It is my opinion that any college graduate who wants to get into labor union work should spend some time in a plant or shop to get personally familiar with the problems of working people and to take an active part in local union affairs.

"We realize the need for more education among the staff employees of our union, but we sincerely feel that this need is not as great as the need for people experienced in the industry with which we deal and experienced with union activities on the local level. Of course, the ideal staff employee is a person who has had this industry and local union experience, plus a college education. We have quite a number of staff members who have both these qualifications."

RAY DAVIDSON,
Publicity Director

Textile Workers Union of America, C. I. O.
99 University Place
New York 3, N. Y.

"Do we hire college graduates who have not come up through the ranks? Less so than in the past and increasingly less so. Every union tries to get as much leadership as possible from within its own membership. As the union matures more and more leadership comes up from the ranks. However, the locals produce few trained lawyers, educators, engineers, economists or journalists.

"The technical departments (legal, research, education, publicity, insurance and health) are now staffed by trained people and will probably continue to be so. Since the departments vary in size from two to ten persons there can be no average turn-over rate. We cannot tell when people will leave and when new people will be needed.

"Unions cannot afford, either financially or politically, to hire untrained people at low wages and choose those who turn out well for continued employment. When jobs do open applicants are sought from among those having these two qualifications: (a) General loyalty to the policies, program and politics of the union. (b) Training in the specific skills required.

"Specific skills required in the various departments include:

Legal — labor law.

Insurance and Health — work in the field of group insurance, social security, even some actuarial statistics.

Research — Industrial engineering, financial and corporation analysis, government economic statistics, cost accounting.

Publicity — newspaper training.

Education — group work, workers' education.

"I would also like to add one further comment which holds true especially for women. A competent stenographer and typist can always get a job in some clerical capacity and then be in a position to get first call on some professional job."

LAWRENCE ROGIN,
Director, Education and Publicity.

At first glance the prospects for a college student who has not had previous experience in these movements do not seem too good. However, you will note that exceptions are made. The positions that might require a college degree are those of union research director, union educational director, newspaper editor, business agent, and organizational director. These positions are not in general that type that an MIT student would be preparing for (with the exception of those in courses XIV and XV). However, in the opinion of Professor Charles A. Meyers, of the Department of Economics and Social Science, there are possibilities of employment in these movements, even for professional men if they are willing to gain experience in the unions first while working in their chosen fields with the various large companies.

While the opportunities for gaining "ready-made" jobs in the existing trade union and cooperatives may seem to be few as far as the average engineer is concerned, the opportunities for creating such jobs are great. The cooperative movement in the United States would gain added momentum if engineers, so vitally important in the development of any company or industry, were willing and able to accept the lower pay involved, and help in the founding of some producing cooperative. The challenge is there. You have only to accept it. The addresses of the smaller production cooperatives are obtainable through the U. S. Department of Commerce.

The replies from the labor unions and the cooperatives were reprinted from the S.D.A. Job Opportunity Catalog by permission of the national organization of Students for Democratic Action.

Statistics for the tables were taken from the U. S. Bureau of the Census Statistical Abstract, 1952 edition.

pistol shooting

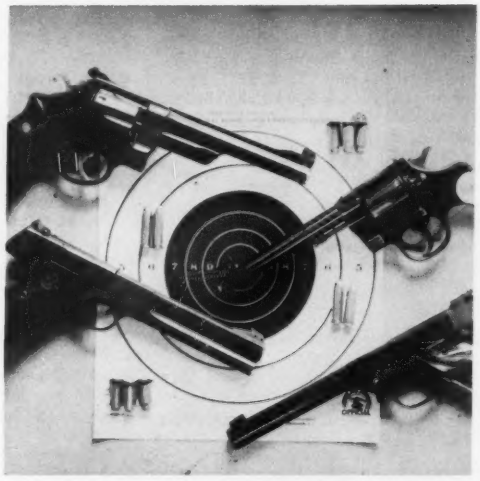
By Ken Klopf, '56

In pistol tournaments the competitor must perform three operations simultaneously and with nearly perfect coordination. These three operations are holding, sighting and squeezing. The rifle shooter also has to do this, but the cost for equipment to start out in pistol shooting is much less than that for rifle shooting. A good rifle costs over a hundred dollars, whereas a good pistol (.22 caliber) costs in the neighborhood of seventy dollars. As auxiliary equipment, a pistol shooter should have a telescope to spot his shots on the target in order to determine flaws in his shooting or the necessity for sight adjustments. A rifle shooter, however, also uses a spotting scope, and he usually finds it a more necessary piece of equipment than the pistol shooter. In this article I intend to discuss the mechanics of pistol shooting (the science) and some helpful hints and tricks (the art) to help you shoot better than average scores. In addition I will give a résumé of the various competitive courses of fire along with a discussion of the types of pistols used in competition.

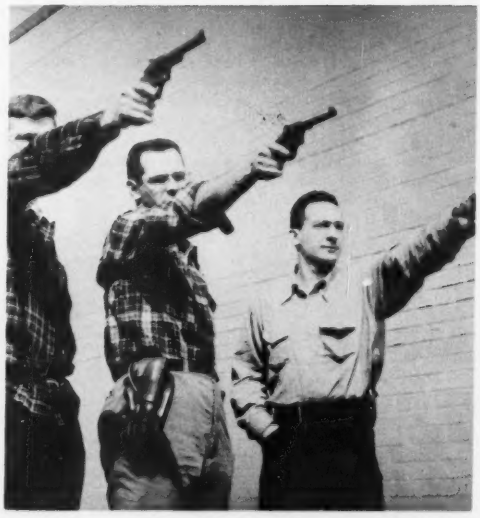
As was stated above, the three maior mechanics of shooting a pistol are holding sighting and squeezing. The National Rifle Association Pistol Rules state the following about a competitor's firing position. "Standing, gun held in one hand only, the other hand and arm being used in no way to assist; all portions of the shooter's clothing, body and gun clear of artificial support. . . . No portion of the shooter's body may rest upon or touch the ground in advance of the firing line." The above rule still leaves considerable latitude concerning the grip on the pistol and the stance taken. When holding a pistol one should take a comfortable position, pointing your arm toward the target while facing the target at about a forty-five degree angle. In this position the average shooter will find the vertical and lateral motion of his extended arm minimized. However, the most stable position for you should be determined by experimentation. Your stance should be varied under changing wind conditions to obtain maximum stability. If there is a strong wind blowing across the targets shooters will face the target more directly to minimize their wind resistance and lessen the lateral motion of their shooting arm. A popular misconception should be cleared concerning the effect of wind on pistol scores. Bullet drift due to wind is insignificant compared to the motion of the shooter's body because of the wind. A stable position is imperative in bad wind conditions in order to produce a good score.

Closely allied to the stance taken is the grip on the pistol. The grip should be uniform for each shot in order to achieve maximum accuracy. This principle is due to the action-reaction principle of physics; the recoil affects the position of the pistol before the bullet leaves the barrel. This fact can be checked by measuring the distance of the front and rear sights above the centerline of the barrel. It will be seen that when the sights are leveled on the target that the barrel is actually bore-sighted below the point of impact of the bullet. Therefore the pistol upon being fired must rise due to the recoil in order to lift the barrel above the horizontal.

Typical target weapons. Left to right (revolvers) Smith & Wesson .38–.44 Outdoorsman and Colt .38 Officer's Model Target. Left to right .22 (semi-automatics) Colt Match Target Woodsman and Hi-Standard GE Model.



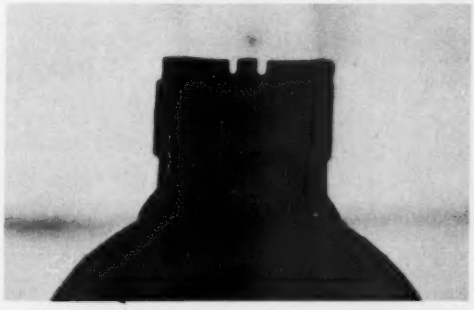
Three members of the pistol team in firing position. Notice their relaxed stomach muscles.



To reduce the non-uniformity of the grip to a minimum, competitive shooters have the grips of their pistols custom made to conform to the configuration of their hand. In the most precise form of pistol competition, free pistol shooting, the grips are so complex that the shooter must work his hand into them as he would into a glove. By taking the proper stance and grip for conditions, the sighting of the weapon becomes almost a mechanical operation. It should be remembered that the best shooting position is one in which one is as relaxed as possible, in order to reduce any tremors due to the tensed muscles. A low center of gravity seems to help in pistol shooting, so when shooting let your stomach muscles relax and sag rather than trying to look like Apollo. The majority of good pistol shooters seem to have healthy, plump stomachs. Whether this is due to the pistoleer slouch or extra elbow-bending exercises at the club is hard to say.

Shooting box equipment. Contains Saturn Spotting scope, twenty-five yard reduced slow-fire target, gun shelf with pistols, and ammunition and accessory compartment.

Exaggerated sight picture illustrating the fundamental sighting principle; always keep your sights in focus and don't focus on the target.



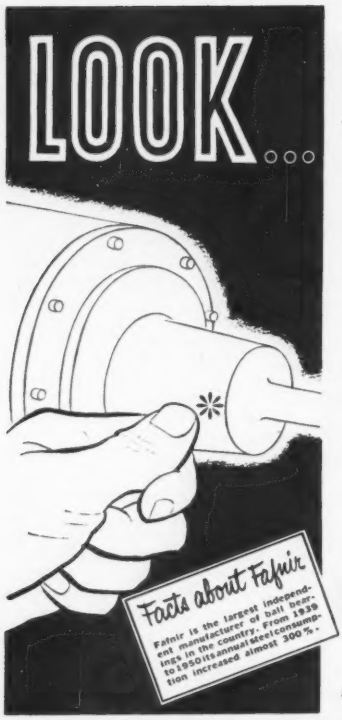
The next step in shooting a pistol is to sight it. The all important rule in sighting is always have the eye focused on the sights and not on the target. In target shooting the target is not going to move, but the sights are; keep your attention focused on the sights. A small misalignment of the pistol on the target will not change the point of impact of the bullet as much as the same misalignment between the sights will. If the pistol is discharged while the sights are in proper alignment but directed to the edge of the ten ring, the bullet will strike the edge of the ten ring and still be scored as a ten. However, if the eyes are focused on a target fifty yards distant (1,800 inches), and the sights move out of alignment by as little as .05 inch, then (if the front and rear sights are approximately ten inches apart) the bullet will strike the target nine inches from the center resulting in a seven instead of a ten (three valuable points down). Therefore it cannot be overemphasized that the eye should be focused on the sights and not on the target. The failure to heed this cardinal rule is the reason why even the best pistol shooters have slumps. It is not easy to keep yourself from focusing on the target, but it has to be done. The sighting picture usually used in pistol shooting is the "six-o'clock hold." This picture places the top of the front sight even with the top of the rear sight and centered in the notch. The pistol with this sight alignment is then brought up so that the black circle of the target appears to be resting on top of the front sight. A method of making small elevation changes in the sight picture is to vary the amount of air in your lungs. By inhaling, the pistol is raised slightly, and by exhaling, the pistol lowered a small amount.

The last step in shooting a pistol is to squ-e-e-ze the trigger. When the sights are in proper alignment with the target, the trigger should be squeezed or pressed smoothly. If the pistol swings off the target, retain the pressure on the trigger until alignment is again achieved and then continue the pressure until the pistol fires. The main point to remember here is to avoid jerking the trigger attempting to catch the target in one grand slam. In the Navy I have seen novices with the .45 service pistol entirely miss, at fifteen yards, a target four by six feet, doing this ten shots in succession just because they jerked the trigger. Even when shooting rapid fire or at aerial targets, the trigger should be squeezed smoothly, only at a faster rate. If you jerk you are one.

By following the above suggestions for holding, sighting, and squeezing anyone can shoot scores that he can be proud of. All he needs is practice, not a genius or birthright.

The three types of matches or courses of fire generally encountered in pistol tournaments are slow, timed, and rapid fire. Outdoors the slow fire course is fired at fifty yards, and the timed and rapid fire courses are fired at twenty-five yards. Indoors all three courses of fire are shot at fifty feet on targets proportionally reduced in size. The diameter of the ten ring in outdoor matches is 3.39 inches for both the fifty and twenty-five yard stages. The following discussion will consider the outdoor matches.

In slow fire the range from the competitor to the target is fifty yards; two five shot strings are fired, and the time allocated for each string is five minutes. Since the range is long and the time is ample in slow fire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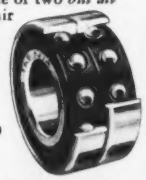
Facts about Fafnir
Fafnir is the largest independent manufacturer of ball bearings in the country. From 1939 to 1950 its annual steel consumption increased almost 300%.

50,000 r.p.m. and not a tremor!

You can put your thumbnail against high speed machine tool shafts supported by Fafnir Super-Precision Ball Bearings and not feel vibration. Such smoothness of operation assures extremely accurate, fast work and prolonged life of parts.

The achievement of such results takes more than skill and care in the manufacture of ball bearings . . . it takes an "attitude and aptitude" for approaching bearing problems from the customer's viewpoint . . . gained from experience in not one or two *but all industries.* The Fafnir Bearing Company, New Britain, Conn.



Fafnir Super-Precision Duplex Type Ball Bearing

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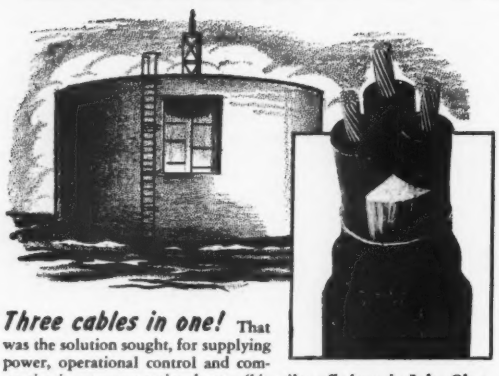

Three cables in one! That was the solution sought, for supplying power, operational control and communication to a pumping house 4½ miles off shore in Lake Okeechobee, Florida.

As usual, Okonite engineers were consulted on the problem. Their studies showed that it was possible to combine a three-fold function in one cable. This was accomplished by the use of Okolite high-voltage insulation whose electrical characteristics permitted carrier current to be superimposed on the power conductors.

The result was a single Okonite-insulated cable — steel-armored for the 4½ underwater miles, with a non-metallic sheath for an additional 2½ miles underground — which supplies not only power and operation control, but a communication circuit as well.

• • •

Tough jobs are the true test of electrical cable . . . and installations on such jobs usually turn out to be Okonite.

OKONITE *insulated wires and cables*

matches, precision becomes the keynote for high scores. Carefully following the rules of holding, sighting, and squeezing, in a slow fire match, will result in an excellent score. The time must be used economically, however, since deep concentration on each shot during difficult wind conditions may allow the allotted time to be expended before the last shot is fired.

In timed fire the precision of slow fire is still evident. In this course the distance from the competitor to the target is twenty-five yards; the scoring rings have the same diameter as those used in the targets at fifty yards in the slow fire course. In timed fire, again, the pistol is discharged in two five shot strings. The time allocated for each string is twenty seconds, which allows four seconds for each shot. Here the time must be carefully watched and a firing cadence developed and followed in order to fire the string in the required time. Due to the short range and the large scoring rings of the target the highest scores in pistol tournaments occur in timed fire matches.

The range and targets used for the timed fire matches are also employed in the rapid fire matches. The difference between timed fire and rapid fire lies in the time given for each of the two five shot strings. In rapid fire the time allowed is ten seconds for each string. This means that there are but two seconds to hold, sight, squeeze, and discharge each shot. The rapid fire course is mastered only by constant practice. A rhythm or cadence must be developed and strictly adhered to if good scores are to be expected.

In addition to the above courses, usually used in local, state, regional, and national matches in the United States, there are the Free Pistol and Rapid Fire Pistol matches which are sponsored by the International Shooting Union. These matches are generally fired in the Olympic Games. The Free Pistol Match is fired at fifty meters on a slow fire target which is quite small (the ten ring is 1.9685 inches in diameter). The pistols used in this match are single shot weapons (usually) that are jewels of precision. The pressure on the competitor and the lightness of the trigger pull used on these pistols can be gathered by the following excerpt from the I.S.U. Free Pistol Match rules:

"Record Firing: Sixty shots (six series of ten shots each), with break of thirty minutes after three series of ten shots. Pistol may rest on front edge of shooting stand, muzzle pointing toward the ground while trigger is being set — if the gun fires before it is lifted from this support the shot will not count against the competitor and may be refired. If the gun fires after it is lifted from the support the shot counts.

Time Limit: Twenty minutes for each series of ten shots.

Sighting Shots: Before each competitor starts to fire his series of sixty shots for record, a period of twenty minutes is allowed during which he may fire as many sighters as desired. In addition he may, within a time limit of five minutes, fire such further sighting shots before each series of ten as he may wish."

The Rapid Fire Match is the most interesting match in my estimation. The rules (excerpts) speak for themselves:

"Arm: Any .22 caliber pistol or revolver.

Range: 25 meters.

Target: Five International type pistol silhouette figures placed 75 cm. between centers. (Each figure is 5′ 3″ high and 1′ 5¾″ wide and is divided into ten rings.)

Shooting Position and Procedure: Standing with the pistol in one hand, arm entirely free. Before the targets are swung into view, the arm must be stretched towards the ground at an angle of approximately forty-five degrees and not raised until targets appear. When shooter is prepared to fire he announces that fact by saying "Ready." The figures appear within five seconds after the shooter reports "Ready" and disappears automatically at the end of the time limit.

Record Firing: Sixty shots, i.e., 30 shot course once repeated. Thirty shots in six series of five shots as follows: two series in eight seconds each; two series in six seconds each; two series in four seconds each. All competitors will complete the first thirty shot course before the second course starts. Each series consists of one shot on each of the five figures.

I have used the term "pistol" in this article to apply to both the semiautomatic weapon and the revolver. The American courses of fire (slow, timed, and rapid) are fired with the .22 caliber, center-fire, and .45 caliber weapons. The best manufacturers of these pistols in the United States are Colt, Hi-Standard, and Smith & Wesson.

Colt manufactures both semiautomatic pistols and revolvers. Colt also manufactures a complete line of target and sport .22 caliber automatics that are used extensively. Hi-Standard has been in existence for little more than twenty years, but because of their constant drive for perfection, their .22 semi-automatic pistols have become almost as widely used as Colts. At the present time many of the top marksmen in America are using Hi-Standards. This company has listened to the shooter's demands, complied with them, gone further, and as a result holds a reputation hard to surpass.

Smith & Wesson manufacture a line of revolvers in all the popular calibers for target, sport, and police work. This company has been in existence almost as long as Colt and their innovation of micrometer click sights, short actions, and ribbed barrels on factory guns has caused their popularity to greatly increase with target shooters throughout the country. "The S & W .357 Magnum has far greater shock power than any .38, .44, or .45 ever tested." This revolver has given remarkable results on big game, and silhouette (man) targets have repeatedly been hit at a range of six hundred yards. Smith & Wesson revolvers show better double-action results than any other revolver. Ed McGivern has hit five aerial targets in the air at once, and has shot five shots in two-fifths of a second with a Smith & Wesson revolver shooting double-action. Even Hopalong Cassidy would envy that.

● LEROY* Lettering equipment is standard in drafting rooms everywhere. No special skill is needed for perfect, regular lettering and symbol drawing. There are LEROY templates in a variety of alphabets and sizes, as well as for electrical, welding, map, geological, mathematical and other symbols that the draftsman needs. *Trade Mark®

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SKF makes all of these eight types of bearings which serve virtually every equipment need. Rely on SKF for *putting the right bearing in the right place.* 3617

SKF INDUSTRIES, INC., PHILADELPHIA 32, PA.

—manufacturers of SKF *and* HESS-BRIGHT *bearings.*

SKF

BALL AND ROLLER BEARINGS

It took a lot of engineering to make a better "grasshopper"

Engineers at Western Electric's St. Paul Shops are well pleased with their new-style "grasshopper" fuse—a small fuse used in Bell telephone central office equipment. The former model—in production for years—had been gradually refined 'til it seemed almost beyond further improvement. It was simple, inexpensive, efficient, came off the line fast. But . . .

It's an old Western Electric engineering custom to keep trying to make Bell telephone equipment still better, at still lower cost. The "grasshopper" was studied by a young engineer out of the University of Minnesota, Class of '40, who joined the Company in 1946. His studies indicated the most effective way to improve efficiency and cut costs further was to change the design.

Pursuing this lead the engineer and his group saw their opportunity to make an important contribution. They investigated the latest tooling techniques, new metals, finishing materials and methods, all of which are constantly under study by engineers at Western Electric plants. A simplified design, which permitted the use of the most modern tooling methods, resulted in a better fuse at lower cost that is saving thousands of dollars a year for Bell telephone companies.

There's an endless stream of such challenging assignments at Western Electric. Engineers of varied skills—mechanical, electrical, civil, chemical, metallurgical—find real satisfaction in working together on the important job of providing equipment for the best telephone service on earth.

How the grasshopper fuse works

Small fuses like this are used by the millions to protect certain telephone central office circuits against current overloads. Odd in appearance, the fuse is called the "grasshopper" because of its spring which is released when the fuse blows, displaying an indicator "flag" in open view and tripping an alarm so the trouble can be spotted and corrected at once.

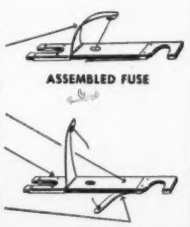
NEW DESIGN

ONE-PIECE FORMED SPRING WITH INDICATING FLAG—MADE BY STANDARD PUNCH PRESS METHODS.

FIBRE STRIP SPRAYED WITH COLORED LACQUER FOR CODE IDENTIFICATION.

INDICATOR SPRING HELD BY AND STAKED TO FLAT TERMINAL—SOLDERING ELIMINATED.

PRE-FORMED RADIAL BEND IS NOT VULNERABLE TO DEFORMATION BY IMPROPER HANDLING—NO ADJUSTMENT FOR TENSION NECESSARY.



• *Engineer and punch press operator check production of parts for newly designed grasshopper fuse.*

Western Electric

A UNIT OF THE BELL SYSTEM SINCE 1882

ME...
an AIRCRAFT engineer?

But I haven't majored in aeronautical engineering

That doesn't matter. Lockheed can train you... at full pay!

It's your aptitude, your knowledge of engineering principles, your degree in engineering that count.

Those—plus the opportunity Lockheed is offering you—are all you need for a career as an aircraft engineer. In Lockheed's special program for engineering graduates, you may go back to school, or you may convert to aircraft work by doing—on-the-job training. But whichever it is, you receive full pay while learning.

But Lockheed offers you more than a career. It offers you a new life, in an area where living conditions are beyond compare. Outdoor living prevails the year-'round. Mountains, beaches are an hour from Lockheed.

See your Placement Officer today for the details on Lockheed's Aircraft Training Program for engineers, as well as the better living conditions in Southern California.

If your Placement Officer is out of the illustrated brochures describing living and working conditions at Lockheed, write M. V. Mattson, Employment Manager

Lockheed Aircraft Corporation

Burbank, California

This Plane made History

The P-38 Lightning – first 400 mile per hour fighter-interceptor, the "fork-tailed Devil" that helped win World War II.

This Plane is making History

The Super Constellation – larger, faster, more powerful; the plane that bridges the gap between modern air transport and commercial jet transport.

This Plane will make History

This plane – which exists only in the brain of an engineer like yourself – is one reason there's a better future for you at Lockheed. For Lockheed will always need engineers with ideas, engineers with imagination, engineers who build the planes that make history.

Preparing for specific responsible positions with Trane in sales, research and product design, these graduate engineers are attending a streamlined six-month training course at full pay. This interesting course moves rapidly and adapts the graduate's knowledge of engineering to the position he has chosen.

Trane Offers Engineering Graduates

OUTSTANDING OPPORTUNITIES IN AIR CONDITIONING

Qualified graduate engineers can step quickly into an interesting and prosperous career in the rapidly growing field of air conditioning. The Trane Company, leading manufacturer of air conditioning, heating, ventilating and heat transfer equipment, is seeking graduates for responsible positions in sales, research, product design and production.

Those selected will join the Trane Graduate Training Program in La Crosse at full pay. Each man will receive a specialized course to assure personal success in the position he has chosen.

He will learn how Trane equipment is used in jet aircraft, tanks, submarines, ships, skyscrapers, factories, industries, homes and buildings of all types. He will see how rapidly air conditioning is becoming a necessity . . . how it is destined to become a standard requirement in homes, automobiles, schools, offices . . . everywhere.

Graduates move quickly into responsible, well paid positions. Men who joined the company through this training program include the president and numerous company officers, managers of most Trane sales offices and home office sales divisions.

Trane's record has been one of steady growth and leadership for nearly forty years, during both peace and war. Today, new Trane products are being developed constantly . . . creating new departments and promotions . . . assuring continued growth and business opportunities.

For an outstanding career in one of the fastest growing industries, consider your future in air conditioning with Trane. Write immediately to Milton R. Paulsen, Training Department Manager, for the brochure "Trane Graduate Training Program". Next six-month class starts in July.

WHAT OTHERS SAY ABOUT TRANE

How much can graduates of their training program earn? What about competition? Is Trane strong financially? Does the company offer outstanding opportunities to young men?

For the unbiased answers, read FORTUNE magazine's report on Trane in their August, 1951 issue. Your library should have a copy. A reprint of this report is included in the "Trane Graduate Training Program" brochure which is in your Placement Office.

TRANE

THE TRANE COMPANY • LA CROSSE, WIS.

Eastern Manufacturing Division, Scranton, Pennsylvania
Trane Company of Canada, Ltd., Toronto, Canada
Sales Offices in 85 United States and 14 Canadian Cities

MANUFACTURING ENGINEERS OF AIR CONDITIONING, HEATING, VENTILATING EQUIPMENT

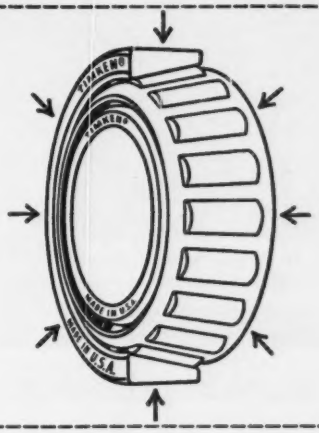
Another page for **YOUR BEARING NOTEBOOK**

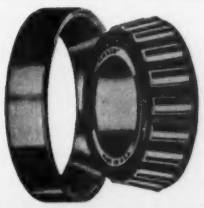
Largest two-crawler shovel keeps going on TIMKEN® bearings

Designed to meet the trend toward larger excavating and hauling units, Marion Power Shovel Co., built a new 10-cubic yard 191-M shovel with a production potential of over 600,000 yards a month. To keep it on the job every day of the month with minimum maintenance, Marion engineers equipped it with Timken® tapered roller bearings at all vital points. Timken bearings carry radial and thrust loads in any combination. Their true rolling motion and smooth finish practically eliminate friction. By keeping housing and shaft concentric, they make closures more effective. Lubrication time and costs are cut.

All loads are the same to a TIMKEN bearing

The tapered design of cup, cone and rollers of Timken bearings enables them to take radial loads, thrust loads, or any combination of the two from any direction. Timken bearings do away with the need for auxiliary thrust bearings or plates. They simplify design, cut costs, save space.





TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS

Want to learn more about bearings?

Some of the engineering problems you'll face after graduation will involve bearing applications. If you'd like to learn more about this phase of engineering, we'll be glad to help. For a copy of the 270-page General Information Manual on Timken Bearings, write today to The Timken Roller Bearing Company, Canton 6, Ohio. And don't forget to clip this page for future reference.

NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER BEARING TAKES RADIAL ⬮ AND THRUST ⬮ LOADS OR ANY COMBINATION ✳

Austin Bush, Rensselaer, '50, Helps Develop New Pump

AUSTIN BUSH, inspecting stuffing box assembly on boiler feed pump.

Reports interesting project engineering assignments at Worthington

"Despite its size as the leading manufacturer in its field," says Austin Bush, "I have found Worthington pays considerable attention to the interests of the individual. The company's excellent training program consists of several months of working with the various types of equipment manufactured, augmented by technical lectures, and talks on the organization of the corporation.

"Following this training, I was given an opportunity to choose the department in which I wanted to work—engineering, sales, or manufacturing. My choice was the engineering department where I have already been assigned to several interesting projects.

"In addition to the training program, the members of our engineering department hold monthly seminars at which engineering topics of general interest are discussed.

"Opportunities for advancement are good, and pleasant associates make Worthington a fine place to work."

When you're thinking of a good job, think *high*—think *Worthington.*

FOR ADDITIONAL INFORMATION, see your College Placement Bureau or write to the Personnel and Training Department, Worthington Corporation, Harrison, New Jersey.

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The Sign of Value Around the World

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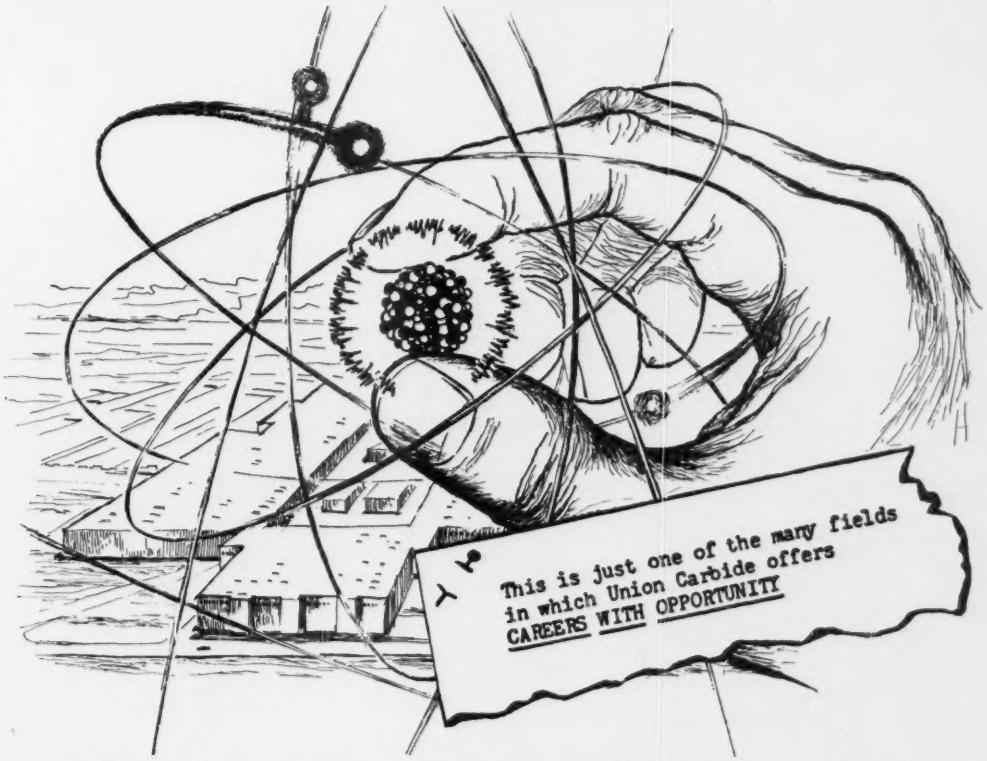

What does Atomic Energy really mean to you?

Dramatic new developments in medicine, agriculture, and industry promise long-time benefits for us all

Scientists have long known that the secret core of the atom concealed vast stores of concentrated energy. Evidence that man had unlocked the secret came with the atomic bomb.

Then came the task of developing methods to release this unbounded energy slowly, gradually, in ways of lasting benefit to all of us.

ISOTOPES AN EXAMPLE—When uranium atoms are split they emit a barrage of highly active particles. Certain chemicals placed in this barrage become radioactive and shoot off particles from themselves. Substances thus treated are called radioactive isotopes.

When these chemicals are made radioactive their paths can be traced through plants and animals, showing the organs they affect. This may increase our understanding of the processes of life itself.

FUTURE UNLIMITED—Atomic energy is also proving useful in industrial research and production. It promises to be even more valuable, however, in providing concentrated power for transportation, home, and industry.

UNION CARBIDE'S PART—From the beginning UCC has had a hand in the mining and treatment of uranium ores, the development of engineering processes, and the production of special materials for the atomic energy program. Under Government contract Union Carbide manages and operates the huge research and production installations at Oak Ridge, Tenn. and Paducah, Ky.

All of this activity fits in with the continuing efforts of the people of Union Carbide to transform the elements of the earth into useful materials for science and industry.

STUDENTS and STUDENT ADVISERS: *Learn more about the many fields in which Union Carbide offers career opportunities. Write for the free illustrated booklet "Products and Processes" which describes the various activities of UCC in the fields of* ALLOYS, CARBONS, CHEMICALS, GASES, *and* PLASTICS. *Ask for booklet D-2.*

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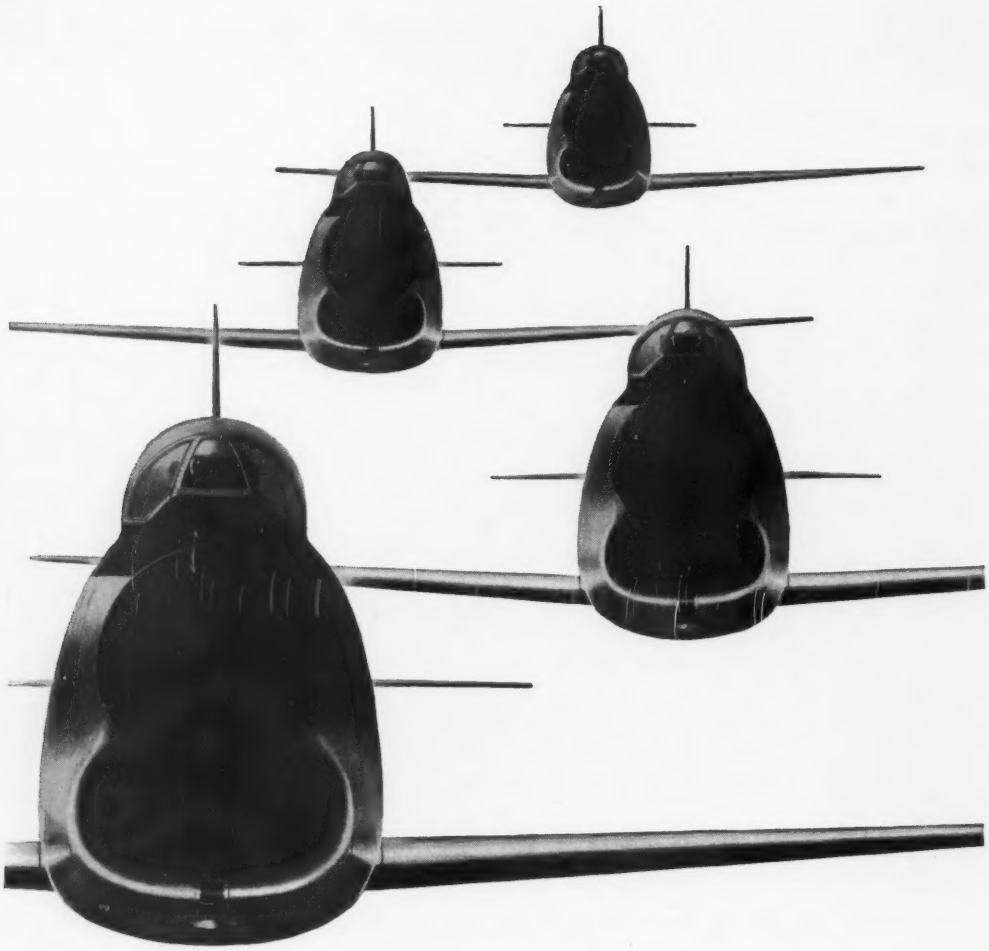
DYNEL TEXTILE FIBERS • BAKELITE, KRENE, and VINYLITE Plastics • LINDE Oxygen • PRESTONE and TREK Anti-Freezes



How would you like to make history?

The men who designed the F-86D *Sabre* Jets you see above made history. And so did the North American engineers who designed and developed the leading planes of World War II—the B-25 Mitchell and F-51 Mustang—and the other advanced planes in the *Sabre* Jet series. For 24 years North American engineers have been making history, because North American thinks in terms of the future. That's why North American always has career opportunities for young engineers who do fresh thinking, for young engineers with new ideas.

Today, North American engineers are making history in exciting new fields, including aircraft, guided missiles, jet engines, rocket development and research, electronics, atomic energy. Why not consider joining them when you complete your engineering training? In the meantime, feel free to write for any information you might want concerning a career in the aircraft industry.

Write D. R. Zook, Employment Director, 5701 W. Imperial Highway, Los Angeles

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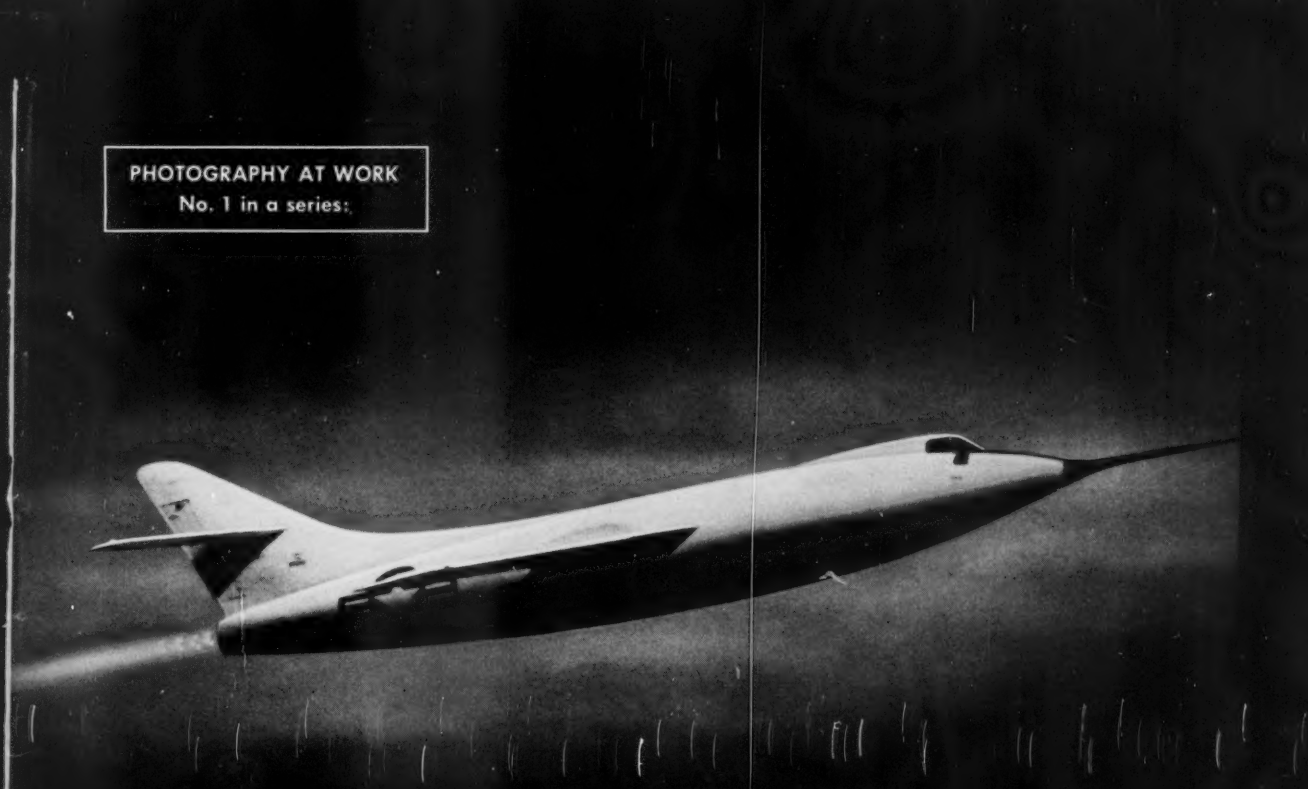

New plane hits 1238 miles per hour!

Camera and film joined in helping produce this Douglas D558-2, which has broken all records by climbing to 14½ miles altitude and reaching 1238 miles per hour.

. . . to speed production, cut costs, here's how the Douglas Aircraft Co. uses Photography throughout its plants

LIKE thousands of other manufacturers and businesses —large and small—Douglas knows the camera is a short cut to greater production at lower cost.

So, from the time a new employee is welcomed to a plant by motion pictures, until a finished plane is on the ramp ready for delivery, photography is hard at work—training workers, testing metals, checking stresses, reproducing drawings, making records, and speeding work in the business offices.

There are countless ways photography saves time and cuts costs. Any business profits when photography gets to work.

There are so many ways photography aids engineering and so many new applications being found, that many well-qualified graduates in the physical sciences and in engineering have been led to find positions with the Eastman Kodak Company.

If you are interested, write to Business and Technical Personnel Department, Eastman Kodak Company, Rochester 4, New York.

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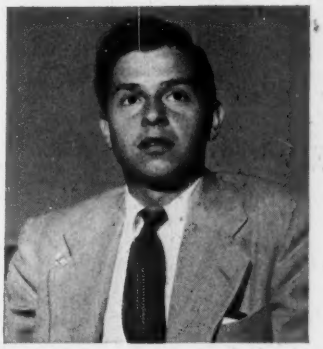
Kodak

MY QUESTION TO THE G-E STUDENT INFORMATION PANEL:

"What opportunities are available in General Electric for a career in manufacturing?"

. . . EARLE E. WARNER, U. of Illinois, 1952



The answer to this question, presented at a student information meeting held in July, 1952 between G-E personnel and representative college students, is printed below. If you have a question you would like answered, or seek further information about General Electric, mail your request to College Editor, Dept. 123-2, General Electric Co., Schenectady, N. Y.

G. C. HOUSTON, *Manufacturing Services Division* . . . In General Electric manufacturing operations involve supervising and administering the activities of more than 100,000 men and women in more than 100 plants. This includes the operation of approximately 75 distinct product businesses, producing some 200,000 different products ranging from heavy industrial equipment to precision instruments and consumers' goods.

The cost of manufacturing our products represents 70% of the total expenditure for all operations including research, engineering, marketing and other administrative functions.

With these activities and expenditures in the field of manufacturing one can readily visualize the breadth of opportunity in the area of manufacturing. This wide scope of manufacturing activities and the importance of their integration into an effective organization provide opportunity for challenging and rewarding careers in such areas as follows:

Manufacturing Supervision: The most important part of any manufacturing organization is men—those who apply their varied skills and talents to perform the many tasks involved in the manufacturing process. To direct the activities of these men, to inspire performance, co-operation and teamwork, to provide fair and equitable treatment, to see that work is done in required quantity—on time—and at the lowest possible cost, is the responsibility of Manufacturing Supervision. It offers a challenging and satisfying career for individual growth and development.

Manufacturing Engineering: This is the creative portion of modern manufacturing. It involves interpretation of initial product designs into good manufacturing practices through planning the methods by which a product will be manufactured, specifying and designing machine tools and equipment, and planning and developing new processes. It is vitally concerned with such subjects as plant layout, materials handling, operation planning, and quality control. It requires a thorough knowledge and broad understanding of how these subjects influence the manufacture of a product.

Purchasing: General Electric is one of the most diversified purchasers in the country today, buying material from every industry. Much of this purchasing involves technical problems, and requires a knowledge of sources of supply, market trends, and new products. Many items purchased are components or finished products of other technical industries. Constant contact with price, as well as evaluation of current and long-range raw material supply situations, is another phase of this activity. It is becoming more and more important as a career opportunity for young men.

In addition to the above described areas of opportunity in manufacturing, such manufacturing services as wage-rate determination, production control, inventory management, production planning and development, and materials handling offer opportunity for highly trained specialization and for competent management supervision.

These areas of manufacturing, together with many others, offer the college graduate of today a wealth of opportunity for a challenging and rewarding career.

You can put your confidence in—

GENERAL ELECTRIC